SCHOOL SCIENCE AND MATHEMATICS

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A WORD FROM YOUR PRESIDENT

PHILIP PEAK

Bloomington, Indiana

We are launching on a new year for the *Central Association of Science and Mathematics Teachers*, and your President is feebly feeling his way along. Did you ever stop to think how various types of Presidents may come and go but the organization continues to develop and prosper? We all accept the assumption that a society can be no stronger than the individuals who compose it, but it seems the frailties of the single person are annulled by the activities of the group. This fact gives your President courage and enables him to live with his deficiencies.

Central Association of Science and Mathematics Teachers has a bright future; however, to attain it every member must put forth his best efforts not only in service within the organization but also in promoting it before the outside world. Professional competition is becoming keener each year, and no professional organization can continue to exist solely on the premise that it includes professional people. Every potential member of the *Central Association of Science and Mathematics Teachers* must weigh the merits of our group against those of a sister organization. No longer do professional people join all the groups to which they are invited.

As I see it, the *Central Association of Science and Mathematics Teachers* has several characteristics which appeal to science and mathematics teachers. First, our organization integrates at every turn the fields of science and mathematics. In educational circles we find a growing conscienceness of the need for interchange of ideas between people in various areas of study. We provide opportunity for such exchange not only at our Annual Convention but again

in the nine yearly issues of SCHOOL SCIENCE AND MATHEMATICS. In this periodical the teacher can find recent information from all fields of science and mathematics.

Second, our organization is so structured that every member can take an active part in its internal operation. No voice is too small to be heard; no idea is thrust aside without a hearing. The Association belongs to the members and only through them collectively are policies formed and activities carried to fruition.

No doubt there are many good teachers merely waiting for an invitation to join the *Central Association of Science and Mathematics Teachers*. Let's each of us see to it that they receive the invitation and at the same time give them special encouragement to attend the Annual meeting in Chicago next Thanksgiving. With each of us doing our share and working together, the *Central Association of Science and Mathematics Teachers* will continue to hold a place of esteem in the culture of our nation.

THREE DEMONSTRATIONS IN ONE

CENTRIPETAL FORCE—WORK AND KINETIC ENERGY—ANGULAR MOMENTUM

JULIUS SUMNER MILLER
Dillard University, New Orleans 22, Louisiana

Fire-polish the ends of a short piece of glass tubing—12 or 15 centimeters long. Through this pass a length of string, a meter or so long. To the ends of the string attach hooked weights of say, 5 grams and 200 grams. Now hold the tube vertically in one hand and by an appropriate twirling of the wrist impart a horizontal circular motion to the smaller mass. The mv^2/r of this smaller mass will now outwit the Mg of the larger one and the larger one may be lifted by increasing the speed of the smaller. This increase in speed of the smaller, however, is accompanied by a larger radius of action. If the motion is timed for any given radius a fairly accurate measure of the centripetal force may be obtained.

Now ask the class: How else may we impart larger velocity to the smaller mass? Or, what happens if we pull down on the lower end of the string, thus reducing the radius of the path of the smaller mass? We pause, and then show the very obvious increase in velocity which arises. Several inquiries then follow: (1) Why the increase in velocity? (2) Where did the increase in kinetic energy come from? (3) If the new radius is $r/2$ what is the new tensile force in the string?

For simplicity, the gravity force on the smaller mass is intentionally negligible. Indeed, it is therefore better to use a 1-gram weight. Hence the only force acting on the smaller mass is the string tension. This is directed perpendicular to the circular path at all points and hence does no work. Therefore the kinetic energy of this mass remains constant, so that it whirls at a constant speed. The only way in which the string tension mv^2/r can do work is by pulling in on the string, which obviously makes r shorter. If, then, the string is pulled in, the work so done is transformed into kinetic energy, and the shorter the radius the greater the velocity. It may be shown mathematically that vr = constant. The same results, of course, may be obtained from the point of view of angular momentum.

EDWIN W. SCHREIBER
1890–1951

The sudden death, December 17, of Edwin W. Schreiber deprives the Central Association of Science and Mathematics Teachers of one of its most active members.

With his pipe, Mr. Schreiber has been a familiar figure at the conventions and board meetings of the Association for many years. He was a member of the Board of Directors from 1929 to 1932. Since that time he became interested in the history of the Association and has compiled a detailed list of all the offices in the organization held, over the years, by the various members. He has assembled one of the few complete files of association year books. He was author of the history chapter in the Association's 50th Anniversary Publication. He was present at the Cleveland convention in November and appeared to be enjoying his usual good health.

Mr. Schreiber was born January 20, 1890, in Saginaw, Michigan. He was married to Elizabeth Norris Patterson in New Castle, Pennsylvania, August 28, 1916. They are the parents of one son, Robert Edwin, a member of the faculty of the University of Maine. One brother, Carl F., the widow, son and one small granddaughter survive.

Mr. Schreiber obtained the bachelor's degree from the University of Michigan in 1911, the master's degree from the University of Chicago in 1924 and did two additional years of graduate work in the University of Michigan.

He was a member of the Masonic Lodge and the Presbyterian Church, which he served as an elder.

Beside his participation in the Central Association, Mr. Schreiber was long a very active member of the National Council of Teachers of Mathematics and was its secretary-treasurer for several years.

He was a member of the N.E.A., the Mathematical Association of America, the Mathematics Association of England, the Deutsche Mathematiker-Vereinigung, and a charter member of the History of Science Society. He was a Fellow of the A.A.A.S.

His special interest was the history and pedagogy of mathematics.

Mr. Schreiber began his teaching career as head of the department of mathematics in the University School for Boys in Chicago in 1911. He taught, successively, in high schools in Yuma, Arizona, New Castle, Pennsylvania, Maywood, Illinois and the University High School at Ann Arbor, Michigan. He became Associate Professor of Mathematics at Western Illinois State Teachers College in 1929. This position, with promotion to department head, he held until his death.

His last complete day was a more or less routine Sunday on which

he taught a Sunday School Class, attended church services and, with Mrs. Schreiber, went out to dinner with friends.

Mr. Schreiber's death was attributed to a massive cerebral hemorrhage and occurred apparently without pain or warning. He was buried in New Castle, Pennsylvania.

WALTER G. GINGERY

ALMA LAIRD
1905–1951

Just about the close of last school year many of us were shocked to hear of the sudden death of D. Van Nostrand's genial high school representative who had attended so many of our recent annual meetings, Miss Alma Laird.

Miss Laird was born November 17, 1905 in Poughkeepsie, New York; died in New York City June 6, 1951 of coronary thrombosis. She was educated in the Poughkeepsie schools and at graduation attended a secretarial school there. Practically her whole business career was spent in publishing. She did work for a short time for an advertising house but soon changed to publishing, where she was active for over twenty-five years. About half of this, from 1936 until its reorganization in 1946, was with Charles E. Merrill Company in their sales promotion and editorial departments. In 1946, upon the organization of Van Nostrand's secondary-school department, she became assistant to the head of the department and departmental sales promotion and advertising manager. She was widely known in education, first in the elementary field and later in secondary education, both academic and vocational. She achieved universal recognition as an expert in these fields, and was known and respected throughout the United States by both academic and vocational educators. During the course of her career she was a member of many associations in the elementary and secondary education fields and her friends numbered in the hundreds.

STANTON WHITNEY
GLEN W. WARNER

Flash guard, for use in taking photographs with flashlights, is a plastic bag-like affair to put over the bulb which gives safety from shattering. It has clear transparent material on one side, and a blue plastic on the other which acts as a filter for color shots.

Foot-warmer, for the office worker or the traffic officer, is a movable rubber mat heated electrically from any convenient electric outlet. The material used is a conductive rubber long used as de-icing installation on airplane propellers and leading edges of wings.

THE USE OF MODELS IN PRESENTING ELEMENTARY CHEMISTRY*

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Department of Chemistry, Oberlin College

To write of the use of models in teaching chemistry is to court the same fate that met the lady who complimented Mrs. Newlywed on her "model husband," only to be immediately wilted by a withering glance for the bride knew perfectly well that a "model" was merely a small imitation of the real thing.

Our models in chemistry are ordinarily large, rather than small, imitations of the real thing but they suffer from the imperfections latent in all models of representing only certain features of the systems they purport to model. No-one should ever confuse the inadequate models we may construct with the real, total situation in the atoms and molecules some of whose properties they represent. The models we shall discuss will, as a matter of fact, be constructed primarily to illustrate the relative sizes of atoms and the relative shapes of molecules and should not be extended beyond these uses with abandon.

DIAMOND AND GRAPHITE

The existence of two forms of the element carbon, diamond and graphite, has been known for a long time. Their differences in properties, some of which are summarized in Table 1, are excellently correlated in terms of the existence of two dimensional plates of atoms

TABLE 1

	Color	Density (g./cm.)	Hardness (Mohr)	Electrical Resistivity (ohm-cm.)
Graphite	Black	2.25	1–2	1.4×10^{-3}
Diamond	Colorless	3.51	10	5×10^{14}

in the graphite as compared with the strong three dimensional bonding present in diamond. The large distance between the plates gives graphite its relatively lower density and hardness. The presence of loosely held electrons which results from the fact that bonding is only in two dimensions in graphite gives it its very low electrical resistivity and its black color for these loosely held electrons absorb incident light. A common model for the graphite is a stack of sheets of paper. Such a stack slides readily in two dimensions but not in the third

* Presented at the Chemistry Section of the Central Association of Science and Mathematics Teachers, Cleveland, November 23, 1951.

and serves as a simple model for the graphite. A more complete model may be readily constructed for the two substances as shown in Figure 1. With this model one can simply account for most of the differences between diamond and graphite in terms of the structural arrange-

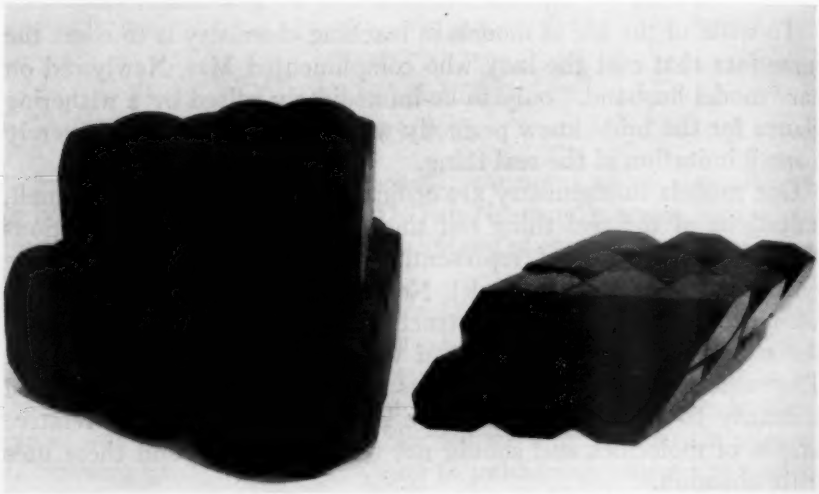

FIG. 1. Models of graphite (left) and diamond (right) showing the two dimensional banding of the first and the three dimensional banding in the second. Each model contains approximately the same number of atoms illustrating the reason for the different densities.

ment of the atoms and the degree to which the electrons are involved in bonding the atoms together in different directions. The very apparent absence of any small molecules in these substances leads to a simple interpretation of the high melting and boiling points of both diamond and graphite for it is clear that many bonds must be broken before small molecular units can be formed to give a liquid or gas.

CONSTRUCTION OF MODELS

Models must be available to the teacher to be of much use. Those listed in this article, and many more such as in the bibliography, may be made with a woodturning lathe by unskilled operators. Their construction would, indeed, afford an excellent project for the woodturning class in any school which operates a wood-working shop. The scale we have used is one inch to the Ångstrom and the author will be glad to send any interested person a complete list of dimensions and angles from which these models may be built. If one wishes to do so, he may purchase cork spheres from the various cork companies and build his models from them. Unfortunately the cork balls come in a limited number of sizes only.

Chemical Reactivity

Perhaps the outstanding difference between the chemical elements from the standpoint of the chemist is the difference in chemical reactivity. This difference may be readily interpreted in terms of relative atomic size using the information in Figure 2. The larger

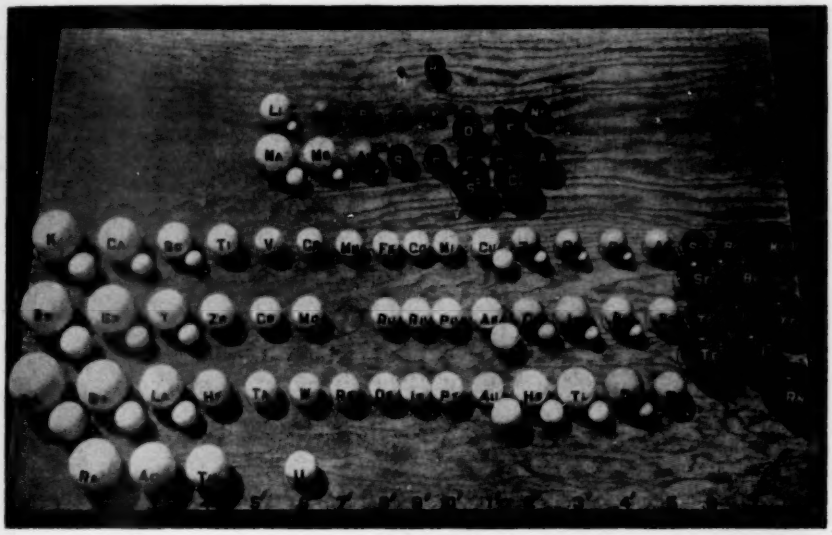

Fig. 2. Relative sizes of atoms and ions, below and to right of corresponding atoms in the periodic system of the elements. Metals are white, non-metals black, and suphoteric elements gray.

the atom the more it will tend to lose electrons in a chemical reaction and the smaller an atom the more it will tend to gain electrons in a chemical reaction. The most reactive elements will be those with the largest and those with the smallest atoms. Elements with atoms of intermediate size will be less reactive. A brief inspection of Figure 2 shows that the only obvious exception to this very simple relationship is the inert gas family. This family really constitutes no problem since the elements are completely inert, forming no compounds. The root of the apparent exception happens to lie in the definition of the size of these atoms and is discussed in the first reference in the bibliography.

It is interesting to note that this concept of size when coupled with a knowledge of nuclear charge allows a ready interpretation of reactivity within a given family of elements. Thus cesium loses electrons much more readily than any other alkali metal because it is the largest atom and the increase in atomic size more than offsets the increase in nuclear charge which would tend to hold the electrons

more tightly. That copper and zinc are much more reactive than gold or mercury respectively would be attributed to the fact that only a small increase in size occurs in descending these families in the periodic system, and that this increase in size is more than offset by the increase in nuclear charge. In the vanadium family and the germanium family the two effects of increasing size and increasing nuclear charge are almost in balance so that each of the three elements in these two families has a reactivity similar to the other two.

Type of Compound Formed when the Elements React

Figure 2 allows one to predict whether an ionic or covalent compound will be formed when two elements interact. Ionic compounds will be formed when an atom with a very loose hold on its own electrons (a large atom) reacts with an atom with a very tight hold on its own electrons (a small atom). The former will tend to lose electrons, the latter to gain electrons, and an ionic compound will form. Thus cesium fluoride will be the most ionic compound which can form for these two elements represent the extreme in size. Similarly the oxides of the metals (which have large atoms) will be ionic, while the oxides of the non-metals (which have small atoms) will be covalent.

Molecular Structure

Since atoms differ in size, molecules will also differ in size. In addition molecules can differ in shape as is shown in Figure 3 which illustrates some of the possible molecules of a few of the non-metals. The diatomic nature of the halogens, and of hydrogen, oxygen, and nitrogen is apparent. The absences of small molecules in graphite and silicon is indicated by terminating each of the models with a plane which means that the crystal actually extends on in the direction indefinitely. In the case of phosphorus, P_4, and sulfur, S_8, small molecules do exist as with the diatomic substances, all of these being covalently bonded.

Behavior of Liquid Sulfur

It is a well known, and often demonstrated, fact that sulfur melts to give a fluid liquid whose viscosity increases with further heating to a maximum after which temperature the viscosity decreases until the boiling point is reached. The great importance of this fact to the Frasch process is usually mentioned. The sulfur molecular model in Figure 3 allows one to interpret the changes vividly in terms of molecular behavior for the atoms in the S_8 molecular model are fastened together by pins which allow the ring to be opened at any point and the resulting chain of atoms to swivel freely about each

bond. It is then easy to point out that the sulfur melts to give a liquid containing rings of eight atoms. These rings slide over one another readily and the liquid is fluid. The increasing energy of motion which comes with a rise in temperature begins to break the rings open to give chains which may actually join ends with other chains to give rather long molecules. In any case the chains become tangled and the viscosity of the liquid rises rapidly as more and more S_8 rings are broken open. Still further increase in temperature results in further breakage of the chains into shorter and shorter segments.

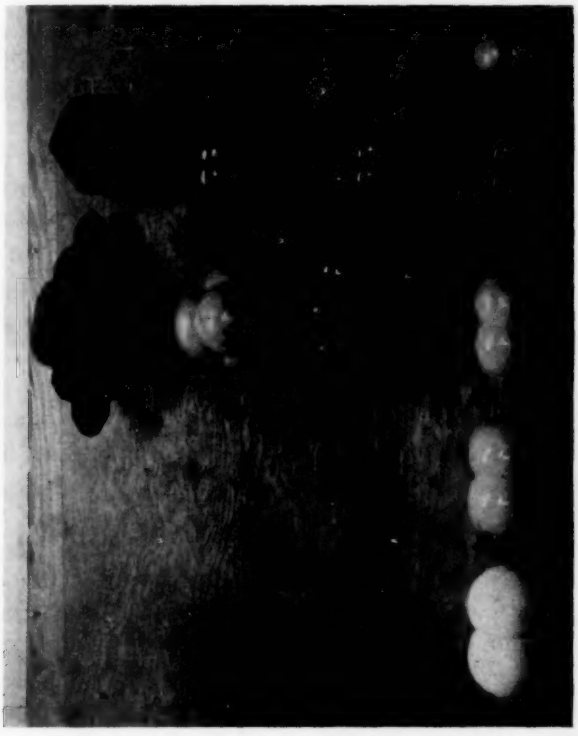

FIG. 3. Models of molecules of some of the non-metallic elements.

The short segments can flow past one another rather easily so that the viscosity decreases again until the boiling point is reached. At the boiling point molecules of gaseous S_2 are formed together with some gaseous molecules of higher molecular weight.

COLOR

The color changes when sulfur is melted and the liquid heated may also be interpreted in terms of the above picture. The S_8 liquid which is formed first is light yellow in color as was the solid. This

color deepens to a red brown as heating continues and becomes almost black at the highest temperatures.

The phenomenon of color will occur, of course, if light of some color is removed from the white light incident on the sample. Since light is a form of energy, light absorption can occur only if the electrons in the atoms and molecules can interact with the light and absorb its energy. To do this the electrons must be rather loosely held in the molecules so that the interaction can occur. We have already pointed out that graphite is black because of its loosely held electrons whereas diamond is transparent since its electrons are held so tightly that they cannot interact with the incident light.

The electrons in the S_8 ring are also rather tightly held so that this substance is not highly colored. When the ring breaks, however

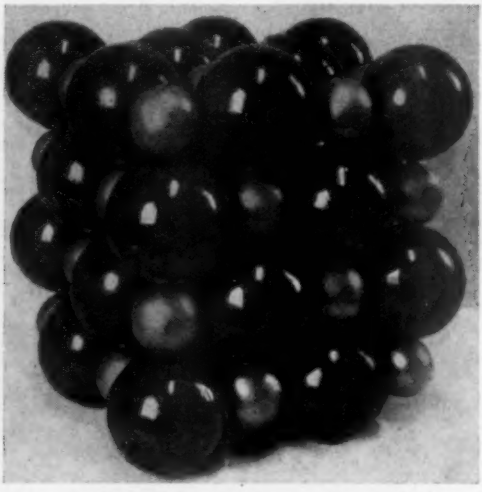

FIG. 4. Model of crystalline sodium chloride.

electrons which were formely engaged in holding the ring together are freed. They are now more loosley held than before, can interact with the light more readily, and the color deepens. The more breaks that occur, the more loosely held electrons there are and the deeper the color becomes since more and more of the light can be absorbed.

An identical argument, based on the models of the halogens shown in Figure 3, accounts for the trend in coloring of these elements. Fluorine is light green, chlorine a deeper greenish-yellow, bromine reddish, and iodine violet. A glance at the figure shows that the iodine molecule is much the biggest of the family. Its outer electrons are, therefore, farthest from the nucleus and least tightly held. Hence they are most free to interact with light and the iodine is most

deeply colored, that is, it absorbs light better. Similar comparisons may be made in many other molecules.

Crystal Faces and Cleavage Planes

A student may well wonder why crystals present such flat surfaces and why they break along planes parallel to these crystal faces. A model such as that of sodium chloride in Figure 4 allows a ready interpretation in terms of the packing of the constituents of the crystal. The sodium ions and chloride ions are arranged in alternating fashion throughout the crystal in planes. The alternating arrangement is forced by the difference in charges on the two ions and the planes of ions result similarly. The ready breakage along these planes follows from the fact that a slight displacement of one layer of atoms with respect to another brings ions of like charge into contact. These ions repel one another strongly and the crystal breaks between the two planes. The behavior of metals may be contrasted. In a pure metal all the atoms are the same and the planes can slide past one another without the onset of any repulsive forces which would tend to cleave the crystal. Metals are, therefore, ductile and malleable, while salts are brittle.

The Existence of Molecules

Models may serve an important purpose also in underlining the fact that small molecules do not exist in all substances. For instance, a brief glance at Figure 4 will convince any student that no "molecules" of NaCl exist in solid sodium chloride. Similarly no small carbon molecules exist in diamond or graphite if one assumes that the models have been properly constructed. On the other hand we have shown that small molecules of the halogens, hydrogen, oxygen, nitrogen, sulfur, and phosphorus do exist.

Melting Points and Boiling Points

The existence of small molecules, or their absence, allows a very simple correlation of boiling points and melting points. The binding forces in small molecules are so concentrated in holding the atoms together in the small molecule that only feeble forces remain to attract the molecules to one another. Hence these substances, such as the halogens, hydrogen, oxygen, etc. have low melting and boiling points. On the other hand substances like diamond and graphite, in which large two and three dimensional groups of atoms are strongly bonded together, have very high boiling and melting points. The salts, or ionic compounds, have intermediate boiling and melting points since the forces between ions are stronger than those between

the small molecules but weaker than those in the covalently bonded substances like diamond.

It should also be pointed out here that there is no correlation bebetween boiling point and molecular weight contrary to much popular opinion. It is not correct to say that high molecular weight, of itself, means a high boiling point. The boiling point of sulfur is above that of oxygen, for instance, not because of the difference in weight, but because of the difference in molecular size (primarily molecular area) and the increased force per unit area of contact between sulfur molecules as compared to oxygen molecules. This increased force per unit area arises from the fact that the sulfur electrons are farther from the nucleus and are freer to interact with neighboring molecules, and hence to attract them, than are the electrons in the oxygen molecules.

Summary

Models may, then, be constructed by any person who has access to a wood-working lathe and are particularly suited for a class project in woodturning. No more information may be extracted from the model than was put into it, but the models do aid in the correlation of chemical reactivities, types of compounds formed when the elements react, color, crystal faces, melting points, and boiling points. Many other properties may also be correlated in terms of the models, and such apparently anomalous behaviors as that of molten sulfur become readily explicable in terms of the molecular structure and its variation with temperature. The articles listed below mention some further extensions in the use of these models and list further articles to which reference may be made.

Atomic Size and The Periodic Table, *Journal of Chemical Education*, *23*, 525 (1946).
Molecular Models, *Journal of Chemical Education*, *25*, 200 (1948).
Structural Chemistry, *Journal of Chemical Education*, *25*, 558 (1948).

Illinois State Normal University

Fifth Annual Spring Conference
on the
Teaching of Elementary and Secondary School Mathematics
Saturday, March 29, 1952
9:00 A.M.—3:00 P.M.

Theme: "A Functional Approach to the Teaching of Mathematics"
Principal Speakers at the morning sectional meetings:
Secondary: Dr. Howard Fehr, Teachers College, Columbia Univ.
Elementary: Miss Anne Gustafson, Supervisor of Elementary Instruction, Rockford, Ill.
Group meetings for both elementary and secondary teachers.
Panel discussion in the afternoon: Dr. Henderson, Univ. of Ill., Dr. Ullsvik, I.S.N.U., Dr. Fehr, Miss Gustafson.

A DIFFERENTIATED METHOD OF TEACHING ARITHMETIC

CHARLES M. DEWITT
Patapsco Neck Elementary School, Baltimore, Md.

The method of teaching arithmetic described in the following paragraphs has evolved through a period of expermentation and search for a method that gives the most recognition to individual differences and permits each pupil to work at a pace that is in accordance with his ability and present state of development. It may contain nothing new nor unique. It may incorporate aspects of practices employed by many other teachers. Though it has been applied only in the middle grades of the elementary school and in junior high school, it may be applicable to a higher level.

The author has observed the practices of a number of teachers of arithmetic who are doing very commendable work. In other instances it has been found that teachers insist that all the members of a class work on the same skill until the majority of the pupils have mastered the skill and then the entire class proceeds to the next fundamental. Under this method some pupils work on the same fundamental far beyond the point of their mastery of it, and to the point of boredom, and those slower members of the class are compelled to proceed to the next step before they master the previous one. In each case all the pupils get the same amount of practice and drill work.

In the average classroom will be found a range of ability a grade or two above and below the grade placement of the pupils. Under the proposed plan the pupils of high ability will master all the skills required for their grade and perhaps much more. They may begin the year somewhere in the text for the grade, and in some cases beyond that, depending on the current stage of development of each pupil. It will be necessary for the slowest pupils to begin in the text a grade level or two lower. If the plan under discussion is continuous over a period of years it can be known each year how far each student progressed the proceeding year thus the pupil advances progressively without missing any of the work and without any unnecessary overlapping. The important thing is to determine the starting point for each pupil irrespective of "grade" or "grade level." This starting point is best determined during the first few weeks of school which most of us spend in some sort of a review of the work of the previous year. Factors that will help us determine this starting point are standardized achievement tests, knowledge of the pupils past performance, and the teacher's judgment of the pupils position by the manifested mastery of skills during the weeks of the review period.

Of course pupils could be arranged in groups which would be close

approximations of their levels of ability. To do so would defeat our purpose which is to draw the fine line of individuality as closely as possible. It is only necessary for the method being discussed that the teacher keep in mind which pupils are currently working on a particular skill. Pupils will not advance as groups but as individuals, for in addition to the factor of individual differences we find that in mastering arithmetic skills pupils show unsuspected spurts of ability in some skills, where as they may lag in others.

Presentation of a new fundamental is presented whenever a reasonable number of pupils are ready for it. Thus at the same time in the classroom we find some pupils being introduced to a new skill and others working on problems for the mastery of previously presented skills and in all, representing a wide range of progress. Individual presentations are necessary for the very few slowest pupils and the very best ones for it would be contrary to our purposes to wait for pupils to catch up merely to be able to instruct a larger group. When the author was first devising this method, in order to provide more time for instruction or supervision, he permitted the faster students to use a period between finishing one assignment and starting another, or before undertaking a new skill, as a free reading period. This, however, discriminated in favor of the best students and unjustly penalized the poorer pupils. This ceased automatically when the competitive element entered in and the better pupils vied with each other to keep ahead; none of them cared to use a free period otherwise and let others forge ahead of them. Often some of the brighter pupils will be able to understand the mechanics of the next step from reading the preliminaries in the text and will continue with the work without seeking and without needing help. This is permissible as long as the instructor maintains a vigil in such cases to see that they are working with understanding.

As there are usually several series of problems on succeeding pages for each arithmetical step it is a good practice for each student to keep in a notebook a two column page indicating the page number and the number of problems in the text that are required for a particular skill and cross them off as he completes them, thus each day he knows exactly where to begin. The author has found it a good practice to maintain a running list of the pages and groups of problems on the blackboard erasing it at one end as the slowest pupil completes the first ones and adding new assignments as the fast pupils progress. In either case, there is never any question in the mind of the pupil as to what he is to do when the time comes for his arithmetic period, as he has to complete a series of practice problems that he started the previous day or begin a new series. The only interruption of this sequence is for the introduction to the next skill along with the same

group of pupils that finish at approximately the same time as he does. There is never any time lost waiting for others to catch up nor any uncertainty as to the task at hand. This keeps all the members of the class continuously working. The customary remarks from the pupils at the first of the year when the plan is first instituted such as "isn't there any let up" or "all we do is work" speak well for the plan. It does not mean that the pupils are being pushed too hard or that the work is too monotonous. Neither does it encourage pupils to work rapidly solely to complete an assignment so as to be able to take it easy when the task is finished, or for the better pupils to rest on their oars.

The most important responsibilities of the teacher in using this method are to be on the alert in determining when a small group of pupils is ready to undertake the next step and give them the necessary preparation, to give assistance to individual pupils, and most important, to determine the amount of drill or practice that is required by each pupil for the mastery of a particular skill. Some pupils will require much more individual assistance and many more practice problems and drill work than others. The better students, in most cases, will not have to work all the series of problems in the text, and some of the slower ones will need more than is provided. The practice problems, or drill procedures in a text are based on the number needed by the average student for the complete mastery of a particular skill. It is a good practice to correct papers for errors and understanding on the spot as much as possible during the period of supervision. On the spot correction, with the proper remedial instruction, means more to the pupil than a "cold" paper returned to him a day or so later.

Under this system pupils soon learn to work continuously and under a certain amount of pressure, since the progress of each can be readily observed. He learns that he is competing with himself, though small competitive factions are always in evidence among the pupils who are employed on the same level of work. The slower students seem willing to accept the ever widening gap between their progress and that of the better students in the class. The author provides a special fifteen or twenty minute period before or after school primarily as a make-up period for absentees and also for giving slower pupils additional help, but this is not made a matter of mandatory attendance for the latter pupils. Much to my great satisfaction, I often find the better students of the class showing up for this period as well as the top pupils who are continually vieing with each other to take the lead in the class.

In addition to allowing a period of free time to the best students in the class, the teacher first employing this method and finding he is

being pressed for time to supervise working pupils or that he has too many presentations of fundamentals to make to groups during a single class period, may give somewhat more than the necessary number of practice problems to certain working groups. These methods, in a sense, defeat our purpose, but both will work as expedients and are justifiable under the circumstances as time control methods. The desirable situation, that can be achieved when both pupils and teacher have had experience working under this plan, is for all the pupils to be continually working, under supervision, at their own pace, with no time wasted in "stops" and "starts," or in waiting for slow pupils to catch up, and with no strain on the slower one to keep pace with the better pupils.

SPIRAL NEBULAE STUDIED BY SERIES OF SHORT EXPOSURES

The arms of spiral nebulae, those gigantic pinwheels in the heavens, trail behind their spinning centers, new evidence indicates.

A series of very short exposures were used by Dr. John B. Irwin of Indiana University to study these heavenly pinwheels of stars and hot gases, most of which are seen edgewise rather than full-view.

The longest exposure of the series was just over three minutes, in contrast with exposures of 20 minutes or more frequently used by astronomers to study these faint, hazy clouds of light.

The short exposures showed the position of the central "hot spot" of the nebulae with great accuracy, Dr. Irwin told the American Astronomical Society. The brightest part of these watch-shaped galaxies is not centered in the apparent center of the spiral as it appears to us, he pointed out. Dust and gas dim our view of part of the nucleus. Thus the apparent center of brightness is displaced toward the galaxy's nearby edge.

The edge of the bright nucleus nearest us is always sharper and less diffuse than the far side, he stated. These two additional tests will help astronomers determine which way a particular galaxy is rotating.

The direction of rotation is of rather fundamental importance in the dynamical theory of these huge systems of stars and gases. Astronomers are not yet agreed as to which direction the spirals are spinning, or whether some are winding their arms up on themselves while others are unwinding.

STRANGE CHEMICAL ISOLATED, EXPLODES AT ORDINARY HEAT

A curious chemical that explodes at ordinary temperature and reacts with everything organic has been isolated and reported to the American Association for the Advancement of Science by Drs. Alfred Engelbrecht and Aristid V. Grosse of Temple University's Research Institute.

Although this purple-vapored green solid and liquid, permanganyl fluoride in chemical composition, was actually first made over a hundred years ago by the German chemist Wohler, called the father of organic chemistry, it had not previously been prepared in its pure state.

The Temple chemists used silica-free glass and transparent plastics in their manufacture of the chemical, which corrodes ordinary glass and quartz.

If it is kept at dry ice temperatures, the compound does not explode and can be kept for months.

PROVIDING A CHALLENGING PROGRAM IN MATHEMATICS AND SCIENCE FOR PUPILS OF SUPERIOR MENTAL ABILITY*

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I am obliged first to interpret the topic for discussion literally. I must identify those people who are going to have a hand in the *providing*. There are the administrators, the college teacher of teachers, the textbook writer, the supervisor of instruction, the classroom teacher, and the student himself. By this last inclusion I am now in conflict with the assigned topic which implies that something is going to be done *for* pupils or *to* pupils. I hold that the highest aim in education is to set the stage, create a situation in which the pupil develops, more and more, the power to provide for himself.

A similar mind set must obtain in every relationship of the previously mentioned group of providers. The supervisor is not going to provide a program *for* the teacher—or similarly up or down the ladder. Any program that is to be acceptable to the group as a whole must be the product of the group as a whole. Nor does one group prepare a program for another group not represented. Creative administration, creative supervision, creative teaching, creative learning, will flourish only in such a climate of freedom, cooperation, democracy.

And we do want creative learning, most of all, for our superior students.

The specific values of any program, course of study, or curriculum materials are determined almost entirely by the ingenuity and skill of the user. We dare not settle for less than the ultimate achievement in both. Programs, and skills in their use, must develop concurrently. Perhaps, if you bear with me, I may arrive at a few of the elements of a program with such values; but first I must indicate some general factors to be kept in the forefront of our thinking.

1. It is not a program until it becomes operative in the lives of all people who are party to it. A program only on paper is not a program.

2. A program can operate with us only as it begins where we are—administrators, supervisors, teachers, pupils. Do we all really know where each one of us is?

3. A program can operate effectively only from recognition of the individual differences in present level and the rates of growth of which we are capable.

* Read at the Senior High School Group program of the Central Association of Science and Mathematics Teachers, Cleveland, November 24, 1951.

4. A program can grow only in so far as it tends to modify our present modes of behavior. We cannot make major transplants or substitutions of living functioning organs or patterns of behavior.

5. A program can grow and flourish only in so far as we, the providers, are permitted to grow with it.

So, from my point of view, the definite proposals, the specific program, the Master Plan—Mein Kampf, recede more and more into the background of my thinking.

I would like to suggest that whatever direction our activity will take from this point on that we consider certain needs, not only of teachers but of pupils, supervisors, and administrators.

We must be aware of these needs not as teachers or pupils, administrators or supervisors, but as members of a team where each one is functioning in any one of the four roles at some time, as well as contributing from the area of his special responsibility most of the time.

There is a need to observe, read and study, plan, experiment, and evaluate good practices, methods and psychology, individualization of instruction, proposed practices, and behavior outcomes under a cooperative plan of shared responsibility. From this array I would select as most imperative the need for experimentation and in the area of individualized instruction.

I sometimes think that there is less honest-to-goodness experimentation in our school science laboratories than almost anywhere. Activity so often consists of regimentation along pre-conceived "steps" of a so-called scientific method toward a pre-determined result with an attendant pre-disposition on the part of the student that is a mockery of modern educational theory.

I think that the almost negligible transfer of the experimental approach from the sciences to experimentation in science education is crushing evidence of the paucity of meaningful experience in so-called science experimentation.

We blame others but we have to blame only ourselves. In order that 32 people may be doing exactly the same thing at exactly the same time we have reduced the level of activity to a plane of mechanical activity assumed to be operational for the lowest level of the class. We take as a measure of our success the degree of uniformity of outcomes—the per cent of our class we are able to bring to the same end point at the same time. The real measure of achievement is (provided that objective is not deliberately sought) the amount of dispersion in our measures of individual student achievement. Teachers of freshman college chemistry who say that their students arrive at the end of the year at about the same general level of achievement whether or not they have had high school chemistry—please note.

Perhaps our greatest failure has been in the individualization of instruction.

The following needs which I would propose as most imperative in program providing will fall into that category: (1) integration with other subject areas, (2) enrichment, (3) acceleration, and (4) guidance.

For definite proposals in relation to a program I would suggest, first, *integration* of science and mathematics. Some very excellent proposals for integration of science and mathematics were made way back in 1900. It is time that some of them were given a fair trial.

Could we have the chemistry teacher or textbook writer proceed not from the premise "What is the minimum requirement in mathematics for passing the subject?" but rather "What is the maximum amount of mathematical understanding I can develop through chemistry?" One of the best mathematics lessons I ever observed was in a chemistry class.

Could we have the mathematics teachers breathe life into their symbols by identification with the real world of science? A mathematics teacher once told me (in reply to such a suggestion) that they did measure the length of a shadow falling into his room once. It struck me as tragic that only a shadow of the real world should ever fall across so many of our mathematics classes.

This shadow suggests the imitation subjects that Mr. W. W. Sawyer writes about so delightfully in "Mathematician's Delight." He says: "The fear of mathematics is a tradition handed down from the days when the majority of teachers knew little about human nature, and nothing at all about the nature of mathematics itself. What they did teach was an imitation." Either mathematics or science taught with a minimum of appreciation of the contribution of one to the other is an imitation.

One of the best physics lessons I ever observed was in a mathematics class—solid geometry.

Special talent may lie in varied or comprehensive fields as well as in fields of narrow specialization. We have consistently destroyed the opportunity for a broad appreciation of the various fields of science, including mathematics, by stressing their major points of difference rather than emphasizing their *common* elements. For too long it has been the exclusive privilege of only graduate students in science to appreciate how intimately related and interdependent the separate sciences really are.

Second, there is a definite need to consider the related problem of *enrichment.*

The very nature of science and mathematics, which are most typical of the logical arrangement, the unalterable sequence and the idea

that it must be all or nothing at all, should have warned us that we are vulnerable.

This can, however, be the source of our greatest strength. I can see no better opportunity for the release of activity in the varied areas of enrichment than where the basic elements and objectives are so clearly defined. We have little difficulty returning to such a clearly established base.

Recognition of individual differences in needs and abilities of pupils require most extensive investigation of the avenues of enrichment. It is inevitable that student needs and subject-matter requirements shall intersect to reenforce each other when careful planning exists.

Some possibilities to be explored in an enrichment program are the addition of new subjects; selecting more difficult materials; making available more supplementary books; providing more opportunities for contacts with interest-arousing institutions, events and people; organizing clubs; encouraging more meaningful pupil activity and accenting the development of initiative.

Third, there is a definite need to consider possibilities for *selective acceleration.*

From *The Student and His Knowledge* by W. S. Learned and Ben D. Wood, we quote:

"Fourteen per cent of the high school seniors surpassed the average of the college senior men 21 years of age."

"In spite of official efforts to make students keep step with the course-credit drumbeat, the bright ones do tend to slip ahead; yet . . . there are many individuals who are just as bright; in their docility they simply have not found the holes in the 'system,' and have consequently been compelled to serve out their time."

"If a freshman in college possesses intelligence that places him with the top ten per cent of the seniors, and displays a command of knowledge in every field that is far ahead of the average fourth year student, why must such a mind still rank as a freshman and remain committed to the same four-year path that is prescribed for a dull or 'average' fellow classman?"

Colleges should provide every opportunity for admission to advanced standing on presentation of evidence of superior high school work.

High schools should—for selected pupils—set such an achievement as a definite goal and take every means to prepare these students for it.

If acceleration within the class group is a desirable thing—and we mean that each student should have the opportunity for full use of his talent and energy—then it follows that selective acceleration in terms of units in the required program might also be considered.

A quite specific program for a "stepped up" program for our best pupil will require what is quite commonly over-looked—a "stepped down" program, not in requirement but at the lower grade levels. The superior mental ability about which we are concerned in the senior high school was present down there in seventh and eighth grade and below. It should be a matter of equal concern there.

Competition of required English, social studies, and other courses in the upper years of high school tends toward elimination of science by the mathematics experts or mathematics by the science experts when they should both be included and concurrent. Earlier course opportunities for exceptional youth would widen his opportunity even under present course offerings.

Fourth, there is a crying need to review the program of ***guidance*** in relation to the fields of mathematics and science.

Lock-step educational programs have resulted in appalling waste in the talent of the superior pupil. Too often it appears a major concern of guidance to fit pupils into the lock-step procedure. Too often high school teachers, like their college teachers before them, have been more concerned about screening out those who did not fit the traditional pattern than in finding the best program for them. The long list of our creative scientists and mathematicians, headed by Einstein, who might ***not*** have emerged under our system, is indeed disturbing.

In the wake of the G.I. program, 50,000 engineers were graduated in one year; the normal output was about 10,000. This does represent some accumulation but for the most part it was only by accident of war and the G.I. bill that much of this talent was recovered. We cannot afford to continue this waste of manpower.

There seems to be a need to broaden the base of our mathematics manpower pyramid. There has been too much tendency toward screening and concern for the specific training for a few, who, as athletes will represent us in competition in the war of mathematics and science ideas. There has been too little attention to the "second team." The mountain climber who alone scales the peak is supported by a string of bases manned by numerous "seconds" upon whom the burden of the monotony and detail falls.

Our body of mathematics students has tended toward the obelisk whose narrow structure tends more and more to be weakened by the seductive attractions of more lucrative fields of endeavor and numerous other factors. We need a broader base to make certain that no talent escapes and that a replacement supply is readily available and that there is a capable group to which may be shifted the lesser responsibilities to relieve the "ace" at the top.

Our once monolithic obelisk rising from a select rugged American

pioneer stock seems to be replaced by a loose aggregate out of a heterogeneous population composing a pyramid with a rather wide limiting angle of repose, whose height of rise will be largely determined by the area of its base.

I would hesitate to recommend wholesale changes or major substitutions in the mathematics program for most of us providers. If there is really any substantial trend it is to continue much as we have been doing. A teacher—who cannot adjust to requirements of different levels of ability by adaptation of the present course with which he is familiar and secure—will show little disposition to work at a program in which he feels strange and insufficient. And in relation to the reaction of all others to a new program, neither do principals nor pupils nor parents change their spots overnight. Or those of you who think in terms of the momentum of moving masses will want to calculate carefully the reaction, in terms of the law of its conservation, coming as a result of sudden changes in speed or direction. The good auto driver and the railroad rails follow the smooth curve of the parabola; they do not swing into sudden circles.

Generally the addition of new courses, in two-thirds of the schools of the nation, will give the mathematics teacher six preparations daily instead of his present four. Whether he would adapt his present courses to the needs of the individuals or introduce two new courses—I would let him decide.

The introduction of new courses in mathematics of specialized areas, as well as refresher courses, clutter up the program and lower efficiency by dissipating teacher energy in many directions. They simply indicate the lack of meaningfulness and continuity of the basic program. They indicate that remedial work, planned practice and maintenance of skills throughout the entire school program of the child were not a part of the original over-all planning.

I do not have a program to propose. I do hope the providers in Pittsburgh and in every city or town will move toward a vital program in mathematics that will serve their special needs. The Cooperative Committee on Science and Mathematics Teaching of the A.A.A.S. has recommended that some national agency be established to collect information about present practices and present achievements. We all need the help of such a fund of information. Our organizations seem to have more leaders and planners than they have followers and diggers. Some one has to get close enough to the great mass of providers to devise practical ways and means of acquiring, organizing, and sharing their product to defeat the fifth column of inactivity. There must be an outlet and incentive.

I propose that we begin, not with a master plan for all the years, of all the children, of all the people, but in line with the problem of

this panel, get down in black and white what we have found most effective for a very specific type at a specific stage of development with respect to very specific objectives. We have barely entered, as yet, the fact-finding phase of our study.

THE ENERGY OF A PROJECTILE FIRED FROM A MOVING PLATFORM

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Mr. J. S. Miller's note on Kinetic Energy in the December number of this magazine (p. 730) interested me and I venture to send an elementary solution of the paradox (or dilemma) in the hope that it may be of interest.

To get away from ships and water, which introduce friction, I modify the problem by putting the man on a frictionless heavy truck moving uniformly on a level track. I also take the Earth as still.

If the man is on the ground and he throws the projectile of mass m (or fires it from a gun) with speed v (relative to the earth) he gives it kinetic energy (KE for short) equal to

$$1/2mv^2. \tag{1}$$

If the man is on the truck which is travelling with speed v, (relative to the earth) and he throws the projectile forward with the same exertion as before (or uses the same gun) the speed of the projectile relative to the earth is $v+v_1$ and its

$$\begin{aligned} \text{KE} &= 1/2m(v+v_1)^2 \\ &= 1/2m(v+2vv_1+v_1^2) \\ &= 1/2mv^2+1/2mv_1^2+mvv_1. \end{aligned} \tag{2}$$

The first term in Eq. (2) is the same as the expression in Eq. (1). The second term in Eq. (2) is the KE of the projectile before it was thrown (or fired). Whence comes the third term of Eq. (2)?

Think of the heavy truck. Let its mass be M. When the projectile is ejected there will be a backward thrust on the truck and the speed of the latter will drop to v_2, say. The decrease of the KE of the truck is therefore

$$1/2M(v_1^2-v_2^2). \tag{3}$$

Does any of this energy go towards the third term of Eq. (2)?

We may replace the M of Eq. (3) by calling in to our help the momentum equation of the projectile and truck. Here on ejection the

momentum is conserved and therefore the momentum gained by the projectile on ejection must equal the momentum lost by the truck at the same time. Therefore

$$m(v+v_1)-mv_1=M(v_1-v_2). \tag{4}$$

From Eq. (4)

$$M=\frac{mv}{v_1-v_2}$$

and substituting for M in Eq. (3) we see that the loss of kinetic energy of the truck

$$=1/2\,\frac{mv}{v_1-v_2}\,(v_1^2-v_2^2)$$

$$=1/2m(v_1+v_2).$$

Since the truck is massive compared to the projectile v_1 and v_2 are very nearly equal to either v_1 or v_2, and replacing v_1+v_2 by $2v_1$ we see that the kinetic energy lost by the truck equals mvv_1 which is just the third term of Eq. (2). Hence all the energy terms of Eq. (2) are accounted for, and the theorem of the conservation of energy seems to hold for a case like this.

I have made the above as simple as I can. One could now proceed to make M and m more comparable. Also I have assumed the ejection of the projectile to be instantaneous whereas actually, whether thrown by the man or fired from a gun, ejection takes time and the speed of the truck drops gradually from v_1 to v_2. As the ingenious correspondent says, the kinetic energy as calculated depends on the axes of reference and to go deeper into the problem would take us out of school mechanics into higher mechanics and recourse would have to be made to such treatment as given, say, in Lamb's[1] *Higher Mechanics*, Chap. IX on "Moving Axes."

[1] Lamb, H. *Higher Mechanics, Second Edition.* 1929. Cambridge University Press. England. Chap. IX, p. 154.

Scare-bird to eliminate the roosting of nuisance birds on city buildings is a mechanical device in the shape of a bird that flaps its wings and turns its head. Operated electrically, this recently patented device is constructed to resemble an enemy bird of the nuisance birds.

Paper umbrellas, resistant to water because coated with a waterproof resin, are cleverly folded in stiff pleats that open up and close down like an ordinary umbrella but eliminate the need for metal ribs. This economical and easily replaced umbrella comes in various colors.

FOUNDATIONS, INDUSTRY AND EDUCATION*

VICE ADMIRAL HAROLD G. BOWEN, USN (RET.)
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Perhaps I can begin with an over-simplified statement by saying that the progress made by any civilization is a direct result of the creativeness and originality of the sum total of the individuals who make up that civilization. We can also see, from a study of history, that a free society which provides the maximum incentive for individual expression makes the most significant contributions to world progress.

We know that our American industrial growth was largely initiated by men who were self-educated, and their original solutions of many problems reflect the importance in invention in all fields—management and technical. The wealth created by the amazing development of American industry has resulted in a multiplication of creative ideas and inventions because each labor-saving device provided more time for more people to *think*.

However, we must raise the question whether our present-day educational system is fitting the glove of formal education so tightly that the criteria of success is not necessarily the originality of an individual but how many formal degrees—gained through rigorous PhD training which in some instances perhaps dulls rather than sharpens the mind—a man can add to his name. Certainly, educational opportunities in a democracy should be available to all; but we must also remember that, within our school curriculums, we should develop teaching methods that do not restrict the teacher to teaching to the lowest common denominator. Individual motivation is a key point in considering methods and curriculum to be employed in education.

Now when one begins a study of the life of Thomas A. Edison, he finds that, perhaps unbeknown to him, he had a methodological approach to self-education.

The Edison method is actually a method of making invention. As a method, it was first described by Roger Bacon; but on account of the tremendous success of Mr. Edison in applying it, it has become known as the Edison method. As a result of carefully studying the Edison method, one is amazed to discover that it was not only a method for making invention but, what perhaps may be vastly more important, it is a method of self-education.

Everyone starts in life with certain characteristics which, if understood and developed, can lead to some kind of success. We are im-

* Presented at the annual meeting of the Central Association of Science and Mathematics Teachers, Cleveland, November 24, 1951.

pressed by the fact that Edison was, by nature, inquisitive and had intense powers of observation. He was an indefatigable worker and was absolutely unable to imitate other people. Lack of imitativeness is a great gift, because it impels an individual who has these other characteristics to do his own thinking.

Edison had about one year of formal education. He simply did not fit in with the type of education which was current at that time in the United States, and his mother removed him from school and gave him the only early education he had. Now his mother had taught school, so she was perfectly competent to teach her son the rudiments of education. But, fortunately for the world, she had much more than that. She had an imagination, and instead of trying to compress her son into orthodox ways of thinking, she encouraged him to continue his experiments and his original and youthful ways of approach to life. She obviously interposed no objections to, for instance, his experiments in chemistry and electricity. She must have encouraged him in the early days when he had a chemical laboratory in a baggage car of a local train when he was printing newspapers and publishing them. The net result was that she had encouraged his sense of originality, founded on his lack of imitativeness, to such a degree that by the time he was fourteen years old he was, to all intents and purposes, self-supporting.

Somehow or other, Edison evolved a technique which most of us have to go to universities in post-graduate courses to acquire. Edison never started an experiment until he had read all existing literature on the subject. He understood, during experimentation, that only one variable could be changed at a time. Edison was always an avid reader and, while he could make quick decisions, he never hurried in his work. There are over 200 books in his library with many of the pages containing comment on the author's opinions and deductions; and every one of these annotations is written in his patient, round-letter form. Edison always had a knowledge of his limitations, which is, after all, the beginning of wisdom.

Edison's success was due to those qualities which we have described; and we must come to the conclusion that there is hardly any individual who, by hard work and application, cannot become a success in life if he can only discover what he has an adaptability for. I think our education today does not sufficiently emphasize the necessity for individual effort. The colleges, universities, and other schools do the best they possibly can in acquainting the youth with authentic and existing sources of information. They cannot be expected to do much more. As someone has said: It is easy to go to college but hard to get an education.

Because of certain changes in the American home, it is doubtful

that we can expect to find many parents who take much pains to encourage their child's activities along the lines which the child himself has selected. But we do feel that education may well strive to emphasize, with each individual, the importance of the individual. Schools have to teach facts. That cannot be avoided, but we must remember that facts are nothing but the shadows of great individuals who have left their mark on the world. We must get behind these facts and tell the pupils how these great men made their contributions. The importance in all history is the work of individuals. It doesn't make any difference whether it is political history, military history, or the history of economics. The important thing is how these individuals worked and what methods they used to achieve their success.

We are living today in the midst of a phenomenon which it is appropriate to call the modern industrial state. In students' histories, emphasis is too often placed on the work of admirals, generals, statesmen, politicians, etc., at the expense of scientists, inventors, and industrialists. This is wrong.

We know of the obvious importance of education to industrial progress. We also see that our industrial growth has created wealth which gives us the leisure time to apply to thinking. Also, we all know that eleemosynary foundations have historically gained their positions due to the originality and resourcefulness of managers of commercial activities who created the wealth which has been applied in an original and pioneering way in the establishment of many private philanthropic foundations with various purposes. Needless to say, education is the chief interest of the largest percentage of the foundations.

Though foundations as they exist in the United States are an American invention, foundations are not new.

The Pharoahs of Egypt in 1400 B.C. established foundations for religious purposes. They hoped that these foundations would be eternal. Plato's famous academy was a foundation—one of the prototypes of an endowed educational institution. It endured for nearly 990 years on income from land; but it was finally suppressed by the Christian Emperor, Justinian.

Roman law early recognized foundations, and ecclesiastical foundations which characterized the Middle Ages became so wealthy and controlled so much land that they became one of the causes of the break between Church and State. The existence of 28,840 foundations in England in the 1830's resulted in English laws which placed some restrictive control over foundations. These laws have, in many instances, become part of American legal practice.

Foundations grew slowly in America because of the lack of the ac-

cumulation of wealth. However, as we would expect, Benjamin Franklin started a couple on his own. The establishment of the Peabody Education Fund in 1867, with its principal objective of advancing education in the South, marks the turning point in the history of foundations. This foundation signified a break from the old tradition of a foundation dispensing relief.

The profusion of foundations as we know them today is a product of the 20th Century and due to the accumulation of capital which resulted from our development and emergence as the foremost industrial state in the world. I shall have more to say about our industrial state later.

There are many types of general philanthropic foundations and, as you probably know, there have been some few abuses in the formation of these nonprofit institutions. However, their over-all record is excellent; and most foundations have fortunately incorporated under broad charters which permit wide choices in the methods of operation and fields of interest. This flexibility is a very key point in the success of a foundation; and, although many foundations have the legal permission for flexibility, it is unfortunate that, in some instances, they follow normal patterns in human association by becoming stereotyped and bureaucratic.

The late Mr. Edwin R. Embree had many interesting things to say about foundations. In his magazine article, "Timid Billions—Are The Foundations Doing Their Job?,"* he has raised some very challenging questions. The fact that he was a Vice President of The Rockefeller Foundation, President of the Julius Rosenwald Fund, and President of the Liberian Foundation should make us thoughtfully receive his comments.

Mr. Embree records that, in 50 years, medicine and public health have progressed to the point where, today, American medical education leads the world. This progress in medicine and public health is perhaps due largely to efforts of the Johns Hopkins Foundation and the Rockefeller Institute for Medical Research. He cites the Rockefeller Sanitation Commission, later merged into the International Health Division of the Rockefeller Foundation, as having made the greatest contribution toward human welfare in ridding the world of so many great contagious diseases. He also cites the work of the Rockefeller Foundation in establishing the University of Chicago.

In higher education and philanthropies "almost invariably the standards were set, in the first place, by institutions under private control, and that when these institutions have proved what is fea-

* "Timid Billions—Are The Foundations Doing Their Job?," by Edwin R. Embree, *Harpers Magazine*, Vol. 198, No. 1186, March 1949.

sible, the task of public authorities in establishing and enforcing these standards everywhere has been made enormously easier."†

In this respect, "the state (has been relieved) of part of its burden."†

Speaking of today, Mr. Embree felt that there are not "comparable instances of creative attack on basic problems."* He felt that there is, at present, a lack of pioneering. He felt as if the research of the physical sciences is nowadays being well handled by universities, industrial laboratories and, recently, the National Science Foundation. "Ironically, pioneering colleges and fresh experiments in education —the only points at which foundations can make creative contributions—are just the ventures that find it hardest to enlist philanthropic support."*

Mr. Embree states further:

"Teacher Education

"America has developed good professional training in medicine, law, and engineering. We have sadly neglected preparation for the most important profession, teaching. The need is not for more or bigger normal schools and teachers' colleges. God forbid! The need is to find and demonstrate sound and realistic preparation for a great profession. The improvement in medical education indicates the profound influence a foundation can have. One of the clearest and greatest opportunities today for private enterprise in philanthropy is in showing the way to make teaching the magnificent profession it must become if America and democracy are to grow to full stature."*

The Thomas Alva Edison Foundation is a novel organization in many respects. It is a discretionary type of foundation and, as an operational organization, has not made any grants to date. It was not founded by Thomas A. Edison but by men and corporations who are interested in perpetuating the work and ideals of Mr. Edison. As you can well imagine, the hopes and ideas for the role that the Thomas Alva Edison Foundation will play in our contemporary society far outrun the financial capabilities of the organization as it is now constituted. This will probably always be true.

It is believed that the Edison Foundation's purpose can best be served by developing programs that will influence the future and not solely restrict attention to recording and glorifying the past. We know from Mr. Edison's own outlook on life and progress that nothing would be more inimical to his own ideas than concentrating too much on antiquity and sentimentality.

In the very broadest sense, the Thomas Alva Edison Foundation as a private organization should move fast and helpfully, as con-

† "Private Fortunes and The Public Future," by Abraham Flexner, *The Atlantic Monthly*, Vol. 156, 1935.

trasted to public institutions, in serving the public by being a pioneer in:

(1) encouraging useful gatherings;
(2) making grants for worthwhile pilot-plant projects; and
(3) stimulating noble undertakings of practical value.

Naturally, the policy of the Edison Foundation will be to preserve and put to use our historic inheritance as represented by the archives.

We do not, however, intend to restrict ourselves to narrow purposes. We feel that we have a great opportunity if we can be bold and daring in our programs. Naturally we cannot cover the waterfront, but we hope that the concentration of effort on a few specific targets that are of intrinsic importance to the substance of Thomas A. Edison's contributions to our civilization will result in programs that will produce the future Edisons however little we mention the past Edison in the process. Thus we can perhaps add to our advancing standard of living by discovering and bringing into production those young Americans who radiate creative and original thinking. Perhaps we can act as a catalyst in bringing together various experts to wrestle with problems that will help the secondary schools to:

(1) teach science better and faster to able students;
(2) discover at an early stage the inquiring curious mind, cultivate it, and bring it out rather than the procedure we now follow in trying to press it back into the mold of conventional thinking;
(3) get keen teachers who are scientists;
(4) show that scientists and engineers are not mysterious wizards but sound workers who use skill, understanding, experimental evaluation, etc., to build a clear science; and
(5) show that some of the greatest inventors are a special kind of scientist who use the background and history of science—the more the better—keenness, hard work, and careful thinking, not wizardry nor haphazard trials.

The Thomas Alva Edison Foundation is at the present time considering a plan, carefully worked out with the cooperation of the National Science Teachers Association and the United States Office of Education, to implement the ideas I have discussed above.

The proposal being considered by the National Science Teachers Association is primarily based on a philosophy that will stir the public to doing the sort of thing in schools that will bring about the initiative to develop the full potentialities of each individual. It is believed that teachers have to generally change the nature of their instruction from sterotyped group instruction to a type of instruction that will give more attention to the individual.

Edison felt that mediocrity was the result of education systems, and he used to say: "Education as now carried on is repulsive to most children. The little they do get is forced. The result is atrophy of the mental faculties. Once atrophied, nothing further can be done. The

child joins the immense mass of mediocres." How true this statement must be today when we learn that the enthusiasm of our eager youth is so dampened that, by the time a child reaches high school, statistics of the U. S. Office of Education show that more than 50% of those entering high school will leave before graduation. Also, in this age of science and its demands on creativeness and originality, less than one-half of the high schools offer courses in physics or chemistry in any one year.

Leaders in education have emphasized the need for individualized instruction, but the mass-education emphasis finds most teachers unprepared to use methods and materials that recognize individual differences. The Thomas Alva Edison Foundation considers that there is a fine opportunity for pioneering work in establishing some mechanical means to translate some of this fundamental thinking into action. Of the four major approaches being considered by the Foundation, I will mention two at this time:

(1) A booklet series of case-studies on Edison's principal inventions and those of other leading American inventors which can be used as collateral reading in schools. These booklets will reflect the industrial history of a particular invention and, through a popularization of individuals contributing to the evolution, a conception of the methods and knowledge applied in each development should give each student an historical inspiration and understanding of some of the principles that he can set down for his own personal career. Such a series may help to incite the imagination of young people.

(2) The Edison series of Science Teacher Institutes would be a direct approach to classroom science teachers. The emphasis would be on bringing to light the best practices for encouraging native inquisitiveness, effective methods for developing the pupil's powers of careful observation, techniques for implementing creative experimentation, and skills for bringing about fruitful reading. What is known about such emphases and how to utilize such ideas in schools would be shared with others in each Institute and the participants would in turn share their enthusiasms and know-how with local associates when they return to their own regions and school communities. The best ideas and the ablest teachers in their use would be brought together in a national Institute where the proposals from regional groups would be evaluated. The best ideas would then be shared with all teachers, especially science teachers, through appropriate publications.

What happens in the class and laboratory periods, what happens in science rooms between and after class periods, and what kinds of school activities pupils will carry on at home—all these depend upon the teacher. No agency is now reaching classroom science teachers through regional and national Institutes.

Seven regional Institutes would be held in widely separated parts of the nation. Four or five science teachers of recognized effectiveness in each of several neighboring states would be invited to meet at a central location for a two-day Institute. Plans for the regional and the national Institutes would be developed by a national committee with someone working part time in coordinating and following through with the plans as developed by this committee. Local committees would work with the national committee in carrying through the detailed plans. All persons would serve without salary or honorarium. Each Institute would be held at a college or university where science teachers are being trained and the staff mem-

bers involved would be encouraged to participate; thus the patterns for training teachers might be re-directed through these Institutes.

Thus, one of the chief educational interests of the Edison Foundation should be to focus attention on the latent potentialities in individuals of the nation. The goal is to arouse them to purposeful individual activity so that the opportunities in schools, homes and communities may be wisely used for self-education. The belief is that such talents are widespread and that some method of discovery and invention in teaching methods can be devised to stimulate, guide, and bring into production these talents.

Please know that when I discuss education, I speak, I hope, with becoming diffidence. I have never taught. After graduation from the Naval Academy and after the conventional six-year cruise, I was ordered ashore to the Naval Academy to become a teacher at that location. Fortunately, I was able to convince the Bureau of Personnel that it would be much better if my orders were changed to duty at an industrial Navy Yard.

It is obvious, then, that any remarks I have made, or will make, on the subject of education must be necessarily comments based on the part of the student.

I never liked the Naval Academy. In the first place, I couldn't study as much as I wanted to nor as much as I needed to because of the complete regimentation of my life; and, having thrust myself into the Naval Academy from a classical high school with brilliant teachers, I was completely unprepared for the Naval Academy as well as for its curriculum. Then, another thing about the Naval Academy I never liked was that we had no instructors. I met but two teachers at the Academy. You simply went to the desk of the so-called instructor—generally a Naval officer and sometimes a civilian—drew a question and with all possible speed attempted to put on a blackboard a convincing argument that you knew the answer to the question.

My experience in post-graduate engineering was entirely different. I met, both at the Navy P. G. School at Annapolis and at Columbia during the second year, some really remarkable educators. This was the first year of the real Navy P. G. School: one year at Annapolis, the following year at a university. For our first year at Annapolis almost all the professors were from Harvard, Columbia and Michigan—and what a galaxy of brains! I had long felt that there was something missing in my educational life, and this experience proved it. Of course, the Naval Academy is a memory course, and your class standing for four years determines your position in the lineal list of the Navy. But, as a matter of fact, the class standing at the Naval Academy really only established a list which graded Midshipmen ac-

cording to their memory. Since memory is an inherited and not an acquired characteristic, I am very much against any such system of rating young hopefuls, whether they are destined for the Navy or for civilian life. The Naval Academy has no interest in deductive or inductive reasoning or originality. Recently, on account of the stories I have heard of the vast number of young men and women who go to college and get nothing out of it, I have somewhat softened in my criticisms of the "grab a written question" system of teaching at the Naval Academy; and I now think perhaps the first or the first and second year at college might well employ the screening and rejection system which is an historic procedure at the Naval Academy.

We hear a great deal about the lack of interest of students—in high schools particularly—in the serious subjects of, for instance, physics and chemistry and engineering; and the newspapers are currently publishing the fact that students entering engineering in colleges and universities are far below national requirements. Referring again to my own experience, which may or may not be outdated, children in their formative years are not exposed enough, if at all, to factual education such as industry can supply. For instance, I never saw the inside of an engine, steam or internal combustion, until I entered the Naval Academy; and when I entered the Naval Academy, it was much more than moving from one school to another—it was moving into an entirely different kind of a world.

I wish there were some way that children at the right ages could witness surgery in hospitals, trials in courts of justice, research in laboratories, and operations in industrial plants in order to broaden their horizons and to give them factual evidence about the various vocations of man which otherwise are nothing but words in their vocabularies.

The greatest thing in the United States is American industry. It fills more wants, relieves more people from the drudgery of labor and fills more mouths than any other single American activity—and I do not mean for a moment to disparage other worthwhile activities, such as the brilliant work of, for instance, the medical profession.

More and more, industry is locating its plants in the country and at the cross roads; and more and more, there is an opportunity for children of school age to visit some local plant where some astounding feat is being performed in physics, in chemistry, or in their application to engineering.

In my life-long attempt to acquire an education, I cannot think of anything I missed more, in my formative years, than the opportunity to visit plants to learn something about the more interesting plant processes right in my own backyard. Most of the books on physics, chemistry and engineering are downright dull and stupid things for a

beginner. The lack of supplementary reading on these subjects and engineering is notorious.

A foundation should pioneer in new ways to better education—in fact, to do some original thinking. The amount of education a person needs is steadily increasing, and it is admitted that all sorts of short-cuts must be used in order to cover the required educational ground within the conventional period. I think this can be done in part by the use of supplementary literature, and I do not know of any better sources for such supplementary literature than foundations, industry and the nearest industrial plant. Industry needs this support from our young people if for no other reason than that industry needs more and more young engineers and scientists.

The solid core of our civilization is American industry; we cannot survive without it. This, I believe, represents a way in which we can help industry help our young people and make our contributions to Western Christian Civilization, of which we are the strongest and the last outpost.

We have noted the fact that the American foundation did not achieve great significance until the 20th century, when outstanding individualists and financiers began to accumulate, in some instances, huge fortunes.

Obviously, somewhere and somehow, great wealth has to be created before great wealth can be accumulated.

The creation of great wealth was the result of the rise of the modern industrial state, and it will be interesting for our purposes to examine for a moment the causes which led to the creation of such a condition.

The foundations of our industrial civilization were laid in the 16th and 17th centuries by a group of great thinkers. These men laid the foundation of science and technology. These great men had the audacity to break with classicism and scholasticism. Among these immortals we may note: Galileo, Copernicus and John Kepler, astronomers; René Descartes, philosopher; Newton, physicist and mathematician; Leibnitz, mathematician; Huygens, natural philosopher and mathematician; William Harvey, anatomist and physician and the discoverer of the circulation of the blood in the body; Vesalius, anatomist; Tycho Brahe, astronomer; John Napier, the mathematician who gave us logarithms; Van Helmont and Robert Boyle, chemists; Sir Francis Bacon, author of *Novum Organum* and glorifier of experimentation; and Edmund Halley, of Halley's Comet fame.

Herbert Butterfield, Professor of History at Cambridge University in England,‡ says that this break with classicism and scholasticism is the most important event in the history of mankind since the birth

‡ "The Origins of Modern Science," by Herbert Butterfield, G. Bell and Sons, Ltd., London, 1950.

of Christ and it crowds into insignificance such episodes as the Renaissance and the Reformation. With him I quite agree.

From that time, the contributions to science and applied science occurred with rapidity and profusion. Man's age-old search for power was realized when Newcomen took the steam engine out of the laboratory and used it to pump water from the coal mines of England. The steam engine was then enormously improved by Isaac Watt, when he hooked it up with a condenser in order to improve its power and its efficiency.

Volta, Ampere, Faraday and others were to lay the foundations of electrical engineering; Hertz was to lay the foundations of radio; and great progress was made in all the other branches of science.

In later times, and particularly in this country, there was a surge of invention which laid the foundations of American industry as we know it today. For want of space and time, I am only listing the 19 inventions that are generally considered to be the greatest in modern times: air brake, George Westinghouse; airplane, Orville and Wilbur Wright; production of aluminum, Charles N. Hall; cotton gin, Eli Whitney; incandescent lamp, phonograph and motion-picture, Thomas A. Edison; induction motor, Nikola Tesla; linotype, Ottmar Merganthaler; oil cracking, William M. Burton; reaper, Cyrus H. McCormick; sewing machine, Elias Howe, Jr.; commercial steamboat, Robert Fulton; telephone, Alexander Graham Bell; telegraph, Samuel F. B. Morse; thermosetting plastics (bakelite), Leo H. Baekeland; vacuum rectifier, amplifier and oscillator (audion), Lee deForest; typewriter, C. L. Sholes; vulcanization of rubber, Charles Goodyear. This list does not include such pivotal inventions as Kettering's self-starter (there were 100,000 automobiles in the United States when the self-starter appeared); the application of the Diesel Locomotive to long hauls (Kettering); ethyl gasoline, Midgely; rayon, nylon and countless others.

There were many men who made great contributions which, by their very nature, were not patentable. For instance, Henry Ford saw all the pieces lying around and he put them together and contributed mass production.

Edison not only invented the incandescent light, but he built the first steam power plant, which represents, in fact, the mass production of electricity; and electricity is commonly believed to be the greatest essential of modern industry.

Since the rise of radio and radar, more and more people are becoming aware of the fact that Edison was the "Father of Electronics," having discovered the Edison Effect which is the most popular and widespread method of producing free electrons. In fact, the Edison Effect provides for the mass production of free electrons. Every time

you turn on your electric lights in your home you are paying tribute to Mr. Edison, who invented the incandescent light and the central power plant with its electrical distribution systems. Every time you turn on your radio, your electric phonograph, or your television set you are employing equipment which uses free electrons, and you are paying tribute to the man who put free electrons into mass production.

Edison probably put more men to work than any human being who ever lived.

Technical Manpower Shortage

Today the United States is facing a desperate situation with respect to the acute shortage of engineers and scientists by the tens of thousands, and this has convinced me of the need for immediately effective action at the high-school level to interest many more students in careers in science and engineering.

Why has there been such a widespread public ignorance and lethargy with respect to an adequate appreciation of this shortage of engineers and scientists?

The modern industrial state, as created by the United States, has caused the center of civilization to move to the North American continent. American industry has come to recognize that engineering and science are the basic growth factors for industry. Witness the records of corporations whose sales records of civilian products show 45 to 60% increases resulting from products developed by their engineers and scientists within the last ten years.

Since the armed services of any nation cannot rise above the technical ceiling set by its own industry, we can readily establish this growth factor of engineering and science as being of vital importance, not only to our civilian economy, but also to our military strength.

The engineers and scientists design, develop, produce and operate the ships, the planes, the guns, missiles, rockets and ammunition, the tanks and armored vehicles, the radio, radar, sonar, loran and other devices of communication and detection—the vast transportation facilities needed in warfare. They are clearly indispensable.

We are desperately short of engineers and scientists. As we progress, the shortage will be greater. As one contemplates the dependence upon engineers and scientists in the task before us, the seriousness of a shortage in this part of our manpower program becomes evident.

Delivery of more horsepower per man at the front by American industry during World War II was the single reason for victory. With man being a tool-using animal, we must therefore depend on our engineers and scientists to constantly develop and produce more power-

ful and efficient tools for both our civilian prosperity and our military strength.

The rapid advances of science are so climacteric that we are in the midst of a revolutionary turning point in the evolution of man's knowledge and its application. Our intellectual and spiritual evolution is ascending on a very sharp curve, while man's physical evolution has almost ceased. The last 100 years have witnessed man's groping for a better understanding of the significance of energy. Material progress of the human race is now measured in the output of goods and services per horsepower employed. Creative minds, able to think in the abstract, are finding new ways every day to satiate man's unquenchable thirst for energy. Science has barely scratched the surface. As Mr. Charles F. Kettering has so clearly stated: "If all knowledge were wrapped up in one package, it would be as one drop of water in the ocean to all the facts which remain unknown."

The United States, more than any other nation, has gone full-steam ahead in recognizing the importance of engineering and scientific research to industrial progress. World War I demonstrated the importance of industrial research in Germany. The United States took the lesson to heart and, by the end of World War II, informed officials in government and industry were keenly aware of the significance of engineering and scientific research and development. For the first time in the history of the world, an art (scientific research) has become self-supporting. The output of the industrial research laboratory has placed research on a wealth-creating basis, and it is now considered the primary basis of our expanding economy, with its consequent effect of raising our standard of living. The unprecedented understanding and acceptance of the vital role of engineering and research as a basis of national strength heralds our entry into a new technological era. A 1500% increase in government research expenditures and a 500% increase in industrial research expenditures from 1940 to 1951 bear witness to the recognition of the fact that high-level scientific activity is necessary to the avoidance of a slowdown or halt in technological progress. In the year 1900 in American industry there was one engineer to every 299 workers, and, in 1950, one to 70. While this positive shift in emphasis on the function of the engineer in industry was taking place, we have not produced new engineering and scientific graduates in the same proportion. The United States' standard of living is primarily an engineering and scientific accomplishment, but there is very little public understanding of the central role the engineer and scientist play in its achievement. The unparalleled standard of living that we enjoy in the United States does not come from longer working hours. On the contrary, working hours have been reduced. Our advantages stem from engineering and

scientific achievements in new products, new methods of manufacture, use of new materials, and effective methods of distribution. It is the engineer and scientist that have been the most significant factors in the rise of the United States to the position of being the producer of one-half of the world's industrial and agricultural production while having only 6% of the world's population and 5% of its land area.

The Unites States today is supporting civilization. It is able to support civilization and finance our defense efforts primarily because of the supremacy of American industry. There are many reasons for this supremacy, some of which are: inventions; a patent law which recognizes ownership of ideas as well as ownership of property; mass production, which of course depends upon a large home market enjoying a sufficiently high scale of living; industrial management relying very heavily on cost accounting; risk capital; research and development laboratories; constantly increasing productivity per man; marketing; transportation; competition; and efficient distribution among our people of the profits of progress.

The destiny of Western civilization in the long run is dependent on the understanding and support which engineers and scientists receive and the recognition of the central role they play in the modern industrial state. The urgent need for increasing our supply of engineers and scientists is one that is of vital importance.

I have particularly called your attention to the fact that present-day foundations, in general, are being criticized because it is felt that they have lost the pioneering instinct. That they are supporting conventional education, yes; but they are not supporting attempts to find out ways and means to improve education and teaching, i.e., they have lost their capacity for original thinking. Nor are foundations financing any efforts to study government and governmental agencies.

Brief reference has been made to some of the many Americans who, as individuals, laid the foundations for our prosperity and, therefore, indirectly supplied the building blocks for our foundations. Continuation of this excellent example and pioneering thinking should prompt the stockholders and management of industry to consider as an investment an increase in corporate support of private education and foundations of the type represented by the Thomas Alva Edison Foundation. As much as possible, such support should be on an unrestricted basis rather than the prevailing policy of quid pro quo, since the maximum benefits are accrued when a foundation or university can be flexible and mobile in rushing resources to needed areas.

It will be a sorry day for our country if the influence of foundations

or the continued support of private education are restricted by excessive taxation. Our present prosperity and high scale of living, which is due to industry more than to any other single cause, was created by individuals and not by Congress or political parties or labor and management, nor is it the result of any ideology of any political party. Any blow struck at foundations which are honestly striving to better our scheme of living will be just another blow struck at American enterprise. Our country was made by individuals and not by organization charts. The public will have to decide how much individual enterprise it wishes to dispense with. French foundations disappeared with the loss of individualism which characterized post-revolutionary France.

I think there is a wonderful opportunity to personalize and color the teaching of science and engineering in our schools in order to build up a greater interest among prospective engineers and scientists. I think we need to talk in our schools far more about the history of science and technology and the wonderful story about these subjects as recorded in, for instance, Professor Butterfield's book, to which I have already referred.

The Thomas Alva Edison Foundation hopes, by working with the National Science Teachers Association, to work out a method whereby more color, personality and individuality may be displayed in the teaching of the sciences and engineering which will thereby provide for a climate for discovery and invention.

In conclusion, may I say:

Competitive industries in a free enterprise system raise the standard of living, thereby releasing people from drudgery and giving them leisure and *time to think;*

Foundations are an institutionalized voluntary way of distributing the wealth created by industry—on a selective basis to pioneering people for *time to think;* and,

Education's prime job should be to train people *to think.* This can only be done by more individualized attention to the pupil because of differences in motivation. If the motivation which first manifests itself by curiosity can be analyzed, seized upon and nurtured, it is very likely that educators can be rewarded by knowing that they have participated in the development of original and creative ideas which, when put to the test of "consumer" (public) acceptance or rejection in a free society, will redound in the further creation of wealth and *time to think* and a resultant constant progress forward of our Western civilization.

A merry heart doeth good like a medicine.—Proverbs 17: 22.

WE CAN DRESS UP GENERAL MATHEMATICS

SOL WHITMAN
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Somewhere along in the school life of too many children all interest in school slowly disappears until by the time the high school level is attained, the desire to attend school has all but vanished. Many parents can attest that their youngsters used to come home and proudly announce that "Today I have some homework" but now groan at the thought of taking home a book.

An answer to the question of what occurred during the intervening years that has caused this change in attitude is obviously not simple. Television, shiny automobiles, broken homes, unstable world conditions, etc., have all played their part. As mathematics teachers, however, we might critically glance into the mirror, so-to-speak, with a view of determining the teacher's role in making the instructional procedures more attractive.

A master teacher must sell his subject to the students just as a good salesman sells any product. Simply exposing the student to the subject with a hope that some of it "will take" doesn't normally produce optimal results. Teaching in this modern age requires that teachers occasionally resort to the spectacular, keep the students in suspense, and use the kind of speech in class that will keep them alert and interested. Instead of intoning the day's lesson with "Today we shall study per cent and apply the problems to accident statistics" would it not be more stimulating to start with "Three hundred shiny new coffins were delivered in this state last month?" Instead of starting with "We shall now study a unit on insurance" couldn't we start with some statement that might cause the students to raise their eyebrows?

As secondary school teachers we know that the vast majority of students do not sit with eager eyes and bated breath, ready to catch nuggets of wisdom. They will, however, react favorably to phrases that have ear appeal. A command to "Strip desks for action" might improve the conventional announcement that "Today we are going to have a test."

It might be well to emulate the technique of Henry Ward Beecher, as related by Milton MacKay.[1]

> Henry Ward Beecher had a genius for bringing the most somnolent audience to life. One July morning he rode to a West Virginia town which was widely known in lecture circles as "Death Valley"—for the reason that any speaker unfortunate enough to have an engagement to lecture wilted and curled up when he faced the town's stupid and indifferent audience.

[1] Borden, R. C. *Public Speaking—As Listeners Like It.* Harper and Brothers, New York, 1935. Pp. 5–6.

Beecher was dully warned. That afternoon, when he was being introduced, half the audience was already dozing. Beecher rose from his chair and, wiping his brow with a large handkerchief, strode to the front of the platform.

"It's a God-damned hot day," the clergyman began.

A thousand pair of eyes goggled and an electrical shock straightened the crowd erect. Beecher paused and then, raising a finger of solemn reproof, went on, "That's what I heard a man say here this afternoon!"

He proceeded into a stirring condemnation of blasphemy—and took his audience with him.

Another technique for enhancing the pupils interest is dependent upon the innate curiosity of boys and girls. For example, a transit or cross-staff standing in front of the room at the beginning of a unit involving principles of similar triangles will invariably result in questioning by a group of the curious as to what the instruments are called, what they are for, whether their group is going to use them, etc. A brief promise to the effect that perhaps some will be allowed to go outside, providing they first learned how to use these instruments, will suffice in arousing anticipation and hope. If the instruments are left standing in front of the room until the unit is completed, the promise or, pedagogically speaking, the motivating force is constantly in the forefront while the pupils are becoming familiar with the instruments.

Most pupils like to see films, film strips, and slides. Allowing the projector to stand in position as much as a day before its use not only paves the way for what will soon be a part of the lesson, but also invites anticipation. Few classes enter a room without the usual "Are we going to have movies today?" If answered with a brief "We'll see" or "Maybe" the element of expectation is assured.

Entirely too often the panorama that occurs in the classroom moves with such swiftness for the slow learner as to be comparable to the patient whose skin was pierced with a needle by a physician who said, "Won't hurt a bit—did it." Too frequently, by the time the slow learner is just beginning to find out what is going on, the unit is over. For the slow learner particularly, it is desirable to create an awareness of what is about to take place without removing the element of suspense. With careful planning it is possible to utilize normal curiosity to help remove the drabness from ordinary classroom procedure.

Most of our general mathematics courses are and should be aimed at improving the ability to handle the fundamentals, namely, addition, subtraction, multiplication, and division of integers, fractions, decimals, and the three cases of per cent. However, these topics are in the main, exactly what the pupil has been drilling on since he started the study of arithmetic. Perhaps the student is somewhat justified when he groans "Studying that again!" in spite of the fact

that his understanding and ability to handle the fundamentals is far from satisfactory. It would seem that if the student hasn't mastered the fundamentals after studying arithmetic through the eighth grade, continued repetitious drill would serve only to set up a psychological block.

Obviously these students need to be given not more meaningless, abstract drill, but rather, a few exercises aimed at improving their understanding of the fundamental operations followed by practical applications based on specific problems. A forty-five minute diet consisting of multiplication of mixed numbers can become extremely boring even for the slowest learner. Finding the volume of a chalk box or a cigar box without a purpose is similarly burdensome.

However, this same problem can be sufficiently "dressed up" to provide genuine motivation and yet utilize identical mathematical skills. Finding the volume of a coal bin, for example, takes on a new meaning if the purpose of the problem is directed towards determining whether or not the coal bin is sufficiently large to hold the entire winter's coal supply. Finding the number of cubic feet of air space in the classroom to determine whether the room complies with the state recommendations of a specified number of cubic feet of air space per pupil generally arouses interest. Naturally it takes more time to establish the background and setting of a problem for complete understanding than would be required for some meaningless exercise but with our zeal for implanting a fair degree of mathematical proficiency, we ought not sacrifice interest.

Although general mathematics is inherently interesting, the caliber of student usually found in these courses compels the instructor to resort to all available devices that might serve to motivate the lethargic pupil. The foregoing techniques, namely, starting the lesson with a dynamic statement, depending on innate curiosity to arouse interest, and substituting understanding and problems with a purpose for abstract drill, might well serve this end.

GOOD NEWS, TEACHERS

I wonder how many of our citizens realize that at the present time many of our educational institutions have been forced to reduce their teaching staffs and to hold instructors down to less than a living wage. . . . It is most heartening that the National Association of Manufacturers is putting the full weight of its support behind the nation's educational program.—ROBERT P. PATTERSON, Former Secretary of War.

Oxygen masks for airplane passengers are a low-cost, disposable type thrown away after use by a single person. Made of polyethylene film, they are light in weight, easy to don and comfortable to wear, and can be quickly connected to the plane's oxygen system.

DEVELOPMENTS IN ANTIBIOTICS SUITABLE FOR PRE-COLLEGE LEVELS*

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My job is teaching at the college level. Naturally, therefore, I am interested also in teaching at the high school level, since the quality and character of the student's preparation often determine his ability to grasp the broader, and at the same time more detailed, type of instruction presented in college.

I have been asked to discuss "Developments in Antibiotics Suitable for Pre-College Levels." The word developments is subject to different interpretations. For purposes of the present discussion, I have interpreted it to mean fundamental principles that are unequivocally established. There is little value in loading the student with detailed factual information which may be outmoded before he graduates. The specific details of production, extraction, and application of antibiotics are changing rapidly as research progresses, but all of these are based on certain principles that do not change. In my opinion, it is these that should be stressed in pre-college education.

With participation in this Workshop for Science Teachers in view, I have been reading some of the recent texts in the biologic and chemical fields of education at the high school level. Reading these texts, several of which are excellent, has left a definite impression on me. These books have many admirable features, but in most of them antibiotics are given a superficial sort of treatment that one might accord an interesting but unimportant novelty. Antibiotics are beyond the novelty stage. The importance in which they are regarded in official circles is attested by the facts that, during the recent war, development and research in this field were top secret—in essentially the same category as the atom bomb—and that materials for authorized research on antibiotics and construction of production plants commanded top priorities. In a brief decade antibiotics have become a powerful social and economic influence, as I will mention later. It is time to get down to earnest business and to discuss them in fundamental terms.

Let us take an example from a popular high school text in biology. Let me say at the outset that this is a very fine text; that it is far superior to the one from which I studied biology in high school, and

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that it is one of which the authors can justifiably be proud. After reading this book, the student has learned that penicillin is a miracle drug and that it was discovered by Fleming. He has also learned that there are several kinds of penicillin and that they are derived from a mold and that antibiotics do not kill sensitive bacteria but merely retard their growth. Some of this is true; some of it is partly true; some of it is not true at all. He has probably also gained the idea that penicillin is some sort of magical shot gun type of cure for most of man's infectious diseases. This, of course, is far from true. Perhaps he has gained the impression also that all antibiotics are obtained from molds. Neither is this true.

But getting back to the facts that he has learned, how much in the way of basic knowledge of antibiotics has he acquired? Penicillin is the best known of the antibiotics and probably should be used as an example. But the teaching should go beyond specific antibiotics. It was less than ten years ago that penicillin first became available on an industrial scale. Hardly a month passes without a new antibiotic being discovered. In this field, advances are being made so rapidly that conceivably before the present high school freshman graduates, penicillin might be outmoded. I say it is conceivable, although certainly it is unlikely. But the basic principle of antibiotic therapy will not be outmoded. This principle is immutable. No matter what new antibiotics may be discovered, no matter which infectious diseases they may help cure, the same basic principles that make penicillin a clinically useful drug today will determine the suitability of these newer antibiotics for therapeutic use tomorrow. Penicillin is but one of more than two hundred antibiotics that have been isolated in relatively pure form. Of these two hundred plus, only seven have proved to be safe for medicinal use and only five can be used safely for internal diseases. Why? What is the principle involved?

This is my first point, then; in instructing high school students in the field of antibiotics, the basic principles are far more important and of more lasting value than detailed factual information about specific antibiotics or the mere memorizing of the names of bizarre antibiotics which currently have no practical use and are unlikely ever to have such use.

What is the fundamental principle upon which antibiotic therapy rests? The answer is "differential cytotoxicity." Now if you toss a phrase like this to the unsuspecting student, probably he will flounder. But the concept can be presented and grasped easily. In simple terms, it means merely that the drug is far more toxic for the invading microbes than for the cells and tissues of the patient. It is the dream on which Ehrlich based his concept of the magic bullet nearly fifty years ago but which did not fully materialize as a reality until

the advent of the modern antibiotic era. One of the greatest virtues of antibiotics over other chemotherapeutic agents (sulfa drugs, arsenicals, etc.) is their very high degree of differential cytotoxicity with the difference in favor of the patient. Very minute amounts of appropriate antibiotics circulating in the blood stream are sufficient to suppress a wide variety of disease germs while relatively enormous quantities are required before any toxic effects are exerted on the patient. To illustrate this idea it can be pointed out that one of the antibiotics, actinomycin, is said to be the most potent drug of its kind that is known. Why, then, is it not used? The answer is insufficient differential cytotoxicity. Actinomycin is more deadly to more disease-causing organisms than any other antibiotic; but it is also deadly to the cells and tissues of man. Therefore, it cannot be used clinically.

It is not necessary for the student to have a technical background, or even to have had a course in biology, to grasp this concept. It does not even involve learning names of diseases or of microbes. Everyone knows what the phrase "to poison" means. Antibiotics, appropriately used, poison microbes without poisoning the patient. It is that simple.

Of course it would be only natural that when this concept is presented to the student, the question should arise, how do antibiotics accomplish this? Why do they display such differential cytotoxicity? We all know that individuals vary somewhat in tolerance for various substances, but in no other class of substances that we have learned about is there such a vast difference as there is between the tolerance of bacteria and of man for the clinically useful antibiotics. In some instances the lethal dose of an antibiotic for bacteria is nearly 1/500,000 of the lowest dose that just begins to show adverse effects on the patient. We have learned that protoplasm is the living stuff of all animals and plants (including bacteria) and that, in general, protoplasm may not be very different in the different forms of life. How can you explain this, the student asks.

Facts, where science is concerned are often unknown. If this were not true, there would be no need for the enormous amount of research which is going on at this campus and at hundreds like it throughout the country. We who are teachers often find it somewhat frustrating to be obliged to tell a student that we "do not know" the reason for this or that. Yet, often this is the only honest answer. This is true in some aspects of antibiotics. However, although the ultimate answers to the questions just raised a moment ago may not be known for several years, it is possible even now, without misleading the student, to give an answer that will be true as far as it goes and that will be compatible with his or her scientific background. It involves

differences in enzyme systems and the concept of threshold concentrations. This is another phrase, just like differential cytotoxicity, that may floor the student. But it can be explained easily. If a needle or any sharp instrument is held against the eyeball or under a finger nail, very little pressure is required to produce a sensation of severe pain. But when the same object is pressed against the finger or the sole of the foot much greater pressure can be exerted without causing discomfort, and if the needle is properly oriented, it may be passed right through the skin, going in one side and coming out the other without causing any pain at all. These tissues have different thresholds of pain sensitivity. Of course the explanation is quite different from that for differential cytotoxicity but, by analogy, it presents the idea of threshold concentrations. It makes little difference that in one instance we are dealing with "concentration" in terms of applied force per unit of surface while with antibiotics we are concerned with true concentration in chemical terms. A simple answer for the question, "Why is there such a great difference between the threshold concentration of clinically useful antibiotics for some bacteria and for animals," is that the enzyme systems of the bacteria are, in several respects, different from those of animals and that the reactions in which enzymes of sensitive bacteria participate are more susceptible to inhibition by antibiotics than are those of most animals. This is due partly to the nature of the enzyme systems themselves and partly to the physical organization of the cells. The lack of mitochondria in bacteria undoubtedly is an important factor. The student probably already has learned that proper functioning of enzymes is requisite for cells to obtain the continuing supply of energy that is necessary for continued life. Inhibition of enzymes cuts off this supply of energy. Therefore, for practical purposes, it may be considered as starving the bacteria. Although this is a highly simplified explanation, there is some evidence to suggest its validity. Bacteria that have been adversely affected following exposure for a few hours to penicillin or streptomycin or some other antibiotic in normal nutrient broth, often are indistinguishable morphologically, especially when properly stained, from bacteria that have never been exposed to the antibiotic but that have been starved by being kept for a somewhat longer time in a culture medium that is deficient in nutrients.

If one desires to delve more deeply into an explanation for the mechanism of action of antibiotics, it is even possible to set up simple demonstrations that will show how antibiotics may interfere with some of the enzyme systems of bacteria.

Thus far we have seen two basic concepts that should be put across to biology classes studying antibiotics in high school, namely the concepts of differential cytotoxicity and of theshold concentrations.

There is at least one more concept that the student should grasp. This is the concept of biologic spectra of antibiotics.

Antibiotics are truly wonder drugs when properly used, but they cannot do the impossible. Recognition of this fact is important. The biologic spectrum of an antibiotic defines the range of its antimicrobial activity. A drug which is effective against a number of different species of bacteria belonging to widely differing biologic classes is said to have a wide spectrum: one which is more restricted in action is said to have a narrow spectrum. Penicillin, for all its clinical usefulness, has a relatively narrow spectrum. This does not minimize its importance. It still is the best drug for use against the germs that cause a number of important diseases. But certain other antibiotics, such as aureomycin and chloramphenicol have wider biologic spectra than penicillin and are capable of curing such widely different ailments as strep infections, staph infections, cholera, virus pneumonia, undulant fever, typhoid fever, typhus fever, and other diseases against which penicillin generally is considered impotent. The point is that each antibiotic has a specific range of activity and a specific use for which it is best suited. None of them is a cure-all. None of the students would use a screw driver to do work for which a wrench is required. Similarly, they should understand that each antibiotic is suited for certain jobs and not for others.

In our high-powered scientific age, one could easily become pretty smug about the discoveries and inventions of the human mind. Perhaps it should be pointed out to the student that man did not invent antibiotics but that these agents have existed among microorganisms for millions of years and indeed may have played some part in evolution and in survival of some species of molds and bacteria and in extermination of others. Even their discovery, or at least their practical use, is not new. Nearly 4000 years ago crude antibiotics were used in China; later they were used by the American Indians, and in the 19th century, partially purified antibiotics were used clinically in Europe. What has been done since the rediscovery of the antibiotic properties of the *Penicillium* mold by Fleming in 1929 is that man has learned how to purify these natural products so that they are safe for systemic use and how to adapt to his own purposes the chemical weapons that micro-organisms use in their every day life. This is no mean accomplishment. It is one of which we may well be proud. But we cannot claim full credit.

One could go on at great length about the biologic and philosophic concepts that could be brought into work on the antibiotics. But possibly I have dwelled on these too long already.

Before discussing the place of antibiotics in high school chemistry, I should like to comment on specific factual type information that

may be in order in biology classes. I have mentioned already that I would base such material on the fundamental action of antibiotics before delving into actual developments which stemmed from these facts. In outlining the developments from these facts for a class, it would be wise to review briefly the five major antibiotics now in common systemic use, i.e., penicillin, streptomycin, aureomycin, chloromycetin, and terramycin. It would also be of interest to identify with these drugs the principal diseases for which they are most useful. Tyrothricin might be mentioned as an example of an antibiotic that is too toxic for systemic use but that has found practical application in gargles and in external treatment of carbuncles and boils. Bacitracin might be mentioned as a drug which is similar to penicillin in biologic spectrum but which because of insufficient differential cytotoxicity has not enjoyed and probably never will enjoy the wide use that penicillin has. But I would not dwell long on these facts, since it really amounts to the student's having to memorize certain names in connection with certain diseases, and there is not much doubt that by the time the student has graduated some of these names will have changed. I cannot stress too often that the basic principles will not change and therefore, these principles should be the prime subject of the discussion.

It should be emphasized that the antibiotics are *natural* products; that they are biosynthetic, that is, that they are synthesized by micro-organisms and are active against other micro-organisms, some of which are causes of important diseases. The statement in a recent biology text that "late in 1946 penicillin was synthesized in the laboratory" is true but quite misleading. The statement in another popular text is even more misleading. I quote, "Until 1946 science had to depend on the fungus itself for the commercial production of penicillin. During the autumn of that year several of the penicillins were produced synthetically, and the supply has now been increased sufficiently to make the penicillins standard products in the treatment of certain diseases." The three statements made in these two sentences are correct but are entirely unrelated. In this age of chemical synthesis it would be only natural for the student to interpret these statements to mean that laboratory synthesis is now the source of penicillin. This of course is not the case. Although penicillin can be synthesized in the laboratory, the synthesis is impractical and all of it is produced industrially by fermentation. The only antibiotic which is available industrially from laboratory synthesis is chloramphenicol. Originally this too was produced biosynthetically.

It would be worth mentioning that the primary source of antibiotic-producing organisms is the soil. True, antibacterial substances have been isolated from "red blood cells of rabbits, . . . decaying

leaves, tomato plants," and numerous other sources, but these are insignificant from a practical point of view and currently have little interest from the research viewpoint. Therefore, why clutter the student's mind with them when one is hard pressed to find time to adequately cover important aspects of the subject? Discussion of them does not in any way contribute to the student's understanding of the subject of antibiotics.

I would point out to the class that antibiotics are far more potent than other germicidal agents. Whereas most of the commonly used antiseptics and germicides inhibit bacteria only in concentrations expressed in terms of milligrams per milliliter, the antibiotics are effective in concentrations expressed in micrograms per milliliter.

How, you ask, is the teacher who often is overloaded with teaching duties and all of the outside work that teaching entails supposed to find time to learn the fundamental principles and concepts of the field of antibiotics, as well as the specific facts that should be taught? Since 1943 there have been published in scientific journals an average of nearly four research papers a day on antibiotics. This adds up to a total of more than 10,000 papers. This year a new monthly scientific journal devoted entirely to antibiotics and chemotherapy made its appearance. Digestion of this literature is a full time job. Several popular books have been written on the subject of antibiotics, but unfortunately most of them are inaccurate and unreliable because they contain half truths or have been so glamorized as to become highly misleading. A few excellent authoritative books have been published in this field but most of these are technical and are useful mostly as reference works for research workers and clinicians. For a general, authoritative but not too technical survey of the field, emphasizing basic principles of fundamental and permanent value, I recommend "Antibiotics" published by the Lippincott Company of Philadelphia. This book is used as a text in several college courses. I do not recommend it for general classroom work in high school, but it should serve as an excellent source book for the teacher. Large portions of it could be read profitably by the better high school students and, if available in the high school library, it should be valuable for special project assignments.

Let us now turn to consideration of antibiotics in high school chemistry. What knowledge that the student has acquired previously may be drawn upon here? The student knows that among the properties of acids is the ability to react with bases to form salts and that, conversely, bases form salts when they react with acids. He probably knows also that free organic acids are relatively more soluble at low pH values in chloroform, ether, and other organic solvents than in water, that at pH values near neutrality the salts are formed, and

that these salts are more soluble in water than in immiscible organic solvents. Here, then, are basic principles that are applied industrially in recovering antibiotics from broth that has been fermented by appropriate strains of micro-organisms.

Penicillin, as it is excreted by the molds that biosynthesize it, is an acid. But it is excreted into a broth which at the time of harvest has a pH of about 8.0. The broth is alkaline. Therefore, impure penicillin exists as a salt. Impurities are removed by adjusting the pH to about 2.0, and mixing the preparation with amyl acetate or some other suitable solvent that is immiscible with water. When the two layers separate, penicillin acid and some impurities are in the solvent phase, and a number of water soluble impurities are discarded with the aqueous phase. Adding to the remaining solvent phase an alkaline aqueous solution, such as one of $NaCO_3$ or of NaOH, converts the penicillin to the sodium salt which, being water-soluble, is found in the aqueous phase when the two layers separate. Impurities that are soluble in organic solvents are discarded with the solvent phase. This experiment can be set up as a laboratory exercise or lecture demonstration that parallels exactly, in simplified form, the large scale industrial methods used in separating penicillin from the impurities that accompany it in the crude fermented broth. It does not require much time. Recently, I demonstrated it quite successfully on a half hour program of the television show "Science in Action," which is produced under the auspices of the California Academy of Sciences. This simple experiment is illustrative of several that can be devised to illustrate chemical principles while also demonstrating the basis of industrial extraction of antibiotics.

Although some antibiotics, such as streptomycin, are bases and others, such as aureomycin and terramycin, are amphoteric, essentially the same principles of pH adjustment and relative solubility in aqueous and organic solvent phases are employed in recovery procedures. In some instances, these are augmented by adsorption and elution techniques, which also are easily demonstrated in the laboratory or lecture hall.

It might be pointed out to the class that antibiotics used for systemic medication (whether they are acidic like penicillin, basic like streptomycin, or amphoteric like aureomycin) are employed in the form of salts.

Possibly it would be desirable to mention the magnitude of the antibiotics industry in connection with the discussion of extraction procedures. Penicillin first became available industrially in December, 1943. Streptomycin followed two or three years later. Yet, despite the fact that for several years only two antibiotics were available for systemic use and that even today only five are available for such use,

for the past two years the income of pharmaceutical manufacturers from antibiotics has exceeded their income from all synthetic medicinals combined. During 1950, American exports of pharmaceutical manufacturers exceeded the exports of any other group of chemical and allied manufacturers and accounted for more than one-fourth of the total chemical exports. Antibiotics accounted for nearly half of the total pharmaceutical exports. The dollar value of antibiotic exports from the United States was approximately eighty-seven million dollars.

What I have suggested in this hour may appear to differ drastically from what is being taught now, or at least to call for an increase in the few hours you have to devote to the single subject, Antibiotics. Science is adding considerably to the subject matter to be taught in high schools these days. But the balance of nature levels off even the scientific subjects, taking from this one and giving to that one. The three major points I brought out to be discussed in biology classes may require more time than does the material which is now covered. In addition, I have increased the discussion of the subject in the chemistry course. Later we shall find it is the basis for new thinking in phases of sociology. You may be saying to yourself that it is not possible to cover such material—that there is not sufficient time.

Here two more points serve to emphasize that time should be found to teach the subject—not as it would be taught to a pharmacy student, of course—but with the thought in mind that a great percentage of the students who graduate from high school end their formal training at that time, and that they should not be ignorant of the fundamental aspects of one of the most significant recent developments of our civilization.

The first of these two points was brought out in the discussion of the commercial importance of antibiotics. Nearly half of the pharmaceutical exports—more than half of all domestic synthetic medicinals combined: these are impressive figures. What other effects have been felt by the world through this new industry—new in the past ten years?

It may be farfetched to think we can impress the youth of the nation with problems they will encounter twenty or fifty years hence. In a few years the present generation will be in the position that the past generation is in now—except that they will undoubtedly live longer than the past generations, our parents and grandparents. If it cannot be brought forcefully to the students, at least you and I should fully appreciate that though we are prone to extol the virtues of new discoveries and inventions, especially when they save us labor or improve our health, not all of these developments are unmitigated blessings. Antibiotics have solved many major problems of disease

and public health, but they are rapidly helping to accentuate a critical social problem. This, then, is the second reason why the subject should not be treated superficially and why time should be found to adequately discuss its fundamental aspects.

Today the five leading causes of death in the United States are non-infectious heart disease, cancer, intracranial lesions, nephritis, and accidents. None of these, with the possible exception of cancer, is of microbial origin. Only a few years ago tuberculosis and pneumonia were the number one and two killers. Antibiotics have played a large part in eliminating infectious diseases from the top ranking killers. What is the result?

The result is that more people are living longer, creating serious social and economic problems. Our population is rapidly becoming one of older people. If our present system of compulsory retirement at an arbitrary chronologic age continues it may not be long before support of this large unproductive population, which is unproductive through no fault of its own, will severely tax the productive capacity of the younger, but smaller, active group. Inevitably it will lower the living standards for all. Perhaps even more important is the social and mental welfare of the older age group which is made inactive at an arbitrary chronologic age even though they are still physically and mentally fit. Often these people soon retrogress mentally when forced into inactivity. Often, unless they have developed other interests, they become tragic misfits in a dynamic society. It is difficult to arouse interest in those of 16 in preparing for when they are 60. But unless this is done, they will constitute millions of unhappy individuals in a few short decades. The remedy rests with them in their youth and with us, the teachers, to help prepare them for this period —to help solve one of the greatest social and economic problems of our time.

This may seem far removed from the topic I was asked to discuss, "Developments in Antibiotics Suitable for Pre-College Levels." But in my mind it is closely related. The trend toward these social and economic problems has been developing for a number of years but has begun to grow at an alarming rate in the last decade due, very largely, to the influence of antibiotics.

Now I should like to take two minutes to summarize.

In discussing antibiotics at the pre-college level I would emphasize basic principles and de-emphasize specific factual information. After all, the detailed facts concerning drugs are the business of the pharmacists and they go to college for from four to six years to learn the subject.

In biology courses I would try to impress upon the student the concepts of differential cytotoxicity, of enzyme interference, of threshold

concentrations, and of biologic spectra. I would point out that antibiotics are natural products derived principally from micro-organisms that normally inhabit soil, and that when properly used they are among the most potent antimicrobial agents. No useful purpose is served by confusing the student with mention of bizarre but unimportant antibiotics.

In chemistry I would stress the principles involved in extraction and purification of antibiotics and in preparing them for use, pointing out how these principles are related to the facts the student already knows about salt formation and the reactions of acids, bases, and amphoteric substances.

Finally, I would try to lead the student to a realization of the impact that widespread use of antibiotics is having on our social and economic structure and to help him prepare for meeting some of the economic and especially social problems that are being intensified by use of antibiotics.

IN APPRECIATION OF BOS INDICUS

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2008 Leghorn, Mountain View, Calif.

Gulf Coast agriculture has been and is undergoing numerous startling changes but perhaps the most spectacular of all is the great expansion in the numbers of beef cattle produced. A steak eaten in New York today may just as well have come from the South as from the West or Mid-West. Yet even the wisest of sages of a few years back would scarcely have prophesied that today Florida would outrank in beef production such veteran western producers as Arizona, Idaho, Nevada, and Utah. Little wonder then, that the American National Livestock Association recently held its convention in the "cattle country" of Florida!

This rapid upsurge in beef production by the Gulf Coast is all the more surprising against a background of many complex problems which have long plagued the struggling beef producers of this area. Included among these problems have been dietary deficiencies, insect pests, and a combination of excessibly high temperatures and humidity in summer. Careful management of animals and forage renovation could largely overcome dietary deficiencies, and widespread application of insect control measures could alleviate much of the insect menace, but the high temperature-humidity problems were seemingly insurmountable. Yet Nature frequently provides relatively simple solutions for those who will but observe.

Beef animals of the lineage of Bos indicus (Brahman-blooded) in contrast with those of Bos taurus (European breeds) are by nature endowed with certain characteristics which uniquely enable them to cope with many of the problems inherent to the Gulf area. Among these characteristics is the large amount of excess skin typical of Brahman-blooded animals which provides a large surface for rapid heat loss. Moreover, this desirable transmission of body heat is but little retarded by the Brahmans' short hair which remains sleek and close to the body. For not only does this hair grow slowly, but under conditions of extreme heat, it seldom, if ever, reaches the length of that found on many cattle native to the temperate zones. Perhaps it isn't surprising, then, that European breeds on exposure to direct sunlight in summer, under subtropical conditions, commonly become feverish, while Brahmans and their crosses are not so affected. Further, these desirable characteristics of the Brahman-blooded animals are combined with an efficient sweating system which the European breeds do not possess. This makes it possible for these animals to graze in heat that induces European breeds to lie in the shade. Such concentration in the shade not only reduces grazing and retards rate of animal growth, but it also frequently results in damage to or destruction of the cover of such shady areas due to excessive trampling and matting. Also, concentration on such shady areas by European breeds may well result in serious over-grazing there, while nearby forage in direct sunlight matures beyond the stage of highest feed value.

Yet the Brahman-blooded animals possess still further advantages for use in the South, in that their skin is more resistant to rupture, which makes it more difficult for insects to penetrate their hides. Their skin also exudes a brownish liquid which serves as a bug repellent. Further, these animals are able to utilize coarse feed on which other cattle would lose weight, and they are willing to travel farther for feed and water. Moreover, there is considerable evidence to indicate that the efficiency in use of feedstuffs by Brahman-blooded animals is such that an additional number of animals may be grazed on the same acreage without over-grazing. In fact, one 25,000 acre ranch south of San Antonio has been able to reduce the pasture-animal ratio to one acre per animal on part of its lands thru pasture improvement and the use of Brahmans. A study by another large ranch indicates that perhaps under some circumstances three Brahman or Brahman crosses can be supported on the same acreage that normally supports two cattle of European strains. It also is significant to breeders that cows bred to Brahman bulls under range conditions take exceptionally well. In an experiment in which 2 Brahman bulls, 2 Hereford bulls, and 100 Hereford cows were run on the range to-

gether, 80 per cent of the calves had Brahman blood!

From the standpoint of marketing, Brahman and Brahman-cross animals possess some additional advantages. They dress-out high percentages of meat (frequently 2 to 6 extra pounds of meat per 100 lbs. on the hoof) and, under proper management, they attain marketable stations at early age—commonly outweighing other breeds by over 100 lbs. at 6 to 10 months. Also when the beef is boned, these animals generally yield an additional 2 per cent of meat as they are smaller boned than European strains. This factor of rapid early growth makes possible a rapid turn-over of the bulk of the beef "crop" in the Gulf Coast as it can be profitably marketed at from 6 to 10 months of age. In fact, much of this beef production in the area can really be termed a "calf-beef" industry.

Significantly, Brahman-blooded animals and a breed such as Santa Gertrudis commonly fatten sufficiently well on pasture alone as to dress-out high percentages (frequently 60 per cent or more) and grade surprisingly high in quality of meat. This enables many Gulf Coast large farm cattlemen who have year-round pasture to ship direct to market with little if any land set aside for erosion encouraging row-crop grain feed production. Many Brahman cattlemen are therefore able to circumvent any dependence on the feed production of the corn belt for final fattening. Moreover, the large farms in the badly eroded areas of the Gulf Coast are thus able to have continual and practically complete forage cover over their entire surfaces which should certainly prove a boon to erosion control in these as well as adjacent areas. These extensive grassland farming methods to which the Brahmans are so well adapted frequently tend to favor large farms and ranches, and these are today exercising an important influence in the Brahman-pasturage development of the Gulf Coast area.

Following the introduction of Brahman bloodlines, beef production in the Gulf Coast area has reached such highs as to cause considerable concern among western range men in eastern market competition. With relatively cheap lands, long growing season, mild winters, and proper management, the Southeast can compete very favorably with the beef industry of other areas regardless of price trends. Large farms and ranches, possessing necessary capital and usually able to hire highly proficient management, are capitalizing on this prospect. Moreover, increased production of cattle in the Gulf Coast area offers opportunity for a cash "crop," adds to the food supply, and at the same time makes possible the use of a high per cent of the farmland.

It can be conservatively estimated that around two-thirds of the beef cattle in Florida have at least some Brahman blood. Similarly,

the Gulf Coast area of Texas has a high proportion of beef animals with varying amounts of Brahman bloodlines. Other portions of the Gulf Coast are somewhat less under Brahman influence, but their bloodlines are rapidly becoming conspicuous in these areas as well.

It would be erroneous however, to assume that this ascendency of Bos indicus (Brahmans) is limited only to the Gulf Coast area of the nation. Rather, Brahman-blooded animals are numerous and increasing in numbers in the Southwest as well. Here Braford (Brahman-Hereford), Brangus (Brahman-Angus), and Santa Gertrudis (Brahman-Shorthorn) are becoming rather familiar terms in the cattlemen's lingo. A recent addition to this terminology is Char-Bra, a Brahman-Charollais cross with the latter being a very big white animal well proportioned and capable of producing large amounts of meat. Generally speaking, the areas having the highest summer temperatures seem to prefer those Brahman crosses which result in animals with lightest colorings, as this apparently gives a slight additional heat resistance.

Bos indicus have long been familiar in their role as the so-called "wild-cattle" of the rodeos. The highly developed nervous systems of these animals have rendered them quite useable for such purposes. Yet, under proper treatment, this very same responsive nervous system contributes to highly desirable beef animals which will energetically produce abundant pounds of beef with amazing rapidity on inexpensive forage.

As Brahman beef contributions increase and become more fully realized, perhaps some day an ode of appreciation will be written to Bos indicus. Commemoration in such a manner could well do honor to these intelligent and highly beneficial animals for their invaluable contributions to the reconstruction of Southern agriculture.

PENICILLIN SAVES LOCKJAW VICTIMS

Penicillin can help save lives threatened by tetanus, or lockjaw, the deadly infection which can get into war wounds as well as those made by stepping on a nail in the garden.

The famous mold remedy can wipe out the tetanus infection in most cases within 24 hours after injections of it have been started, four Puerto Rican scientists report in the *Journal of the American Medical Association*. The four are Drs. R. S. Diaz-Rivera, Emilio Ramirez, Eduardo R. Pons, Jr., and Mercedes V. Torregrosa, all of San Juan.

Antitoxin is needed to neutralize the toxin, or poison, produced by the tetanus germs, they point out. But penicillin helps save patients by stopping the growth of more germs, and thus preventing more toxin getting into the patient's body.

In the cases they reported they used both tetanus antitoxin and penicillin, in addition to surgical cleaning of the wound and sedatives to stop the convulsions and spasms.

A STUDY GUIDE*

PRESENTED BY THE MATHEMATICS DEPARTMENT,
IOWA STATE COLLEGE

D. L. HOLL

"A taste for mathematics, like a taste for music, can be generated in some people, but not in others. Students not having a strong bent for mathematics should make every effort to overcome their shortcomings and dislikes. First, try to appreciate that mathematics is basic in much of our scientific knowledge both theoretical and practical. What we can understand of the world and what we can do with machines, we can understand and do by virtue of mathematics. Second, try to minimize your difficulties by apprehending central principles so that the edifice of mathematics becomes a single temple embodying a unitary plan rather than a collection of detached hovels." *Author unknown.*

This guide has been written to help *you*. It has been written primarily for students in mathematics, but it is hoped that it will prove helpful to students in other fields and suggestive to instructors. You are not expected to digest all of it at one reading.

A. GENERAL INSTRUCTIONS

1. "Go easy" on the extracurricular activities until you have tried yourself. Your studies come first.
2. Find out as soon as possible if you have command of the fundamentals for the course. If you do not, ask your instructor for a conference about it.
3. A good start in mathematics is very important. "Get down" to work the very first day of the term.
4. Free yourself from bad habits in mathematics which your instructor will point out to you.

B. HOW TO STUDY

1. Study the assignment as soon as possible after it is given to you.
2. Schedule your study time. Choose a time to study your mathematics when you are rested and your mind is alert. It is not always possible to have the ideal situation. Do not wait for the proper mood to strike you—by going through the motions of studying, you may acquire the proper mood. Turn off the radio, pull up a straight chair and sit down in an erect position at your study table, have pencil and

* In continuation of the series of brief articles which may help the beginning teacher of mathematics on the elementary college level, Professor D. L. Holl, Head of the Mathematics Department at Iowa State College at Ames was asked to write a brief article in the form of a letter. Professor Holl in reply sent the study guide saying, "I feel that although this study guide is presented directly to our freshman students, it is by all odds the best material I can offer my new instructors. We ask that our new instructors read and digest its contents very carefully."

While this is a longer article than some which have preceded or will follow, it seems to have very valuable help for the beginning teacher irrespective of the level.

CECIL B. READ
Mathematics Editor

paper handy, then—go after the lesson just as you would rush into an athletic contest.

3. Concentrate on your lesson. If there are unavoidable distractions, overcome them. Do not use them as excuses for not doing your work.

4. You should learn as much as you can from the textbook before going to class.

5. Get acquainted with the text. Learn how to use its helps.

6. Read through the assignment with the specific purpose of discovering the central idea of the author. Do not try to work out all the details of the material in the first reading. Read at a moderate rate. Look up the definitions of terms with which you are not familiar.

7. Read the material again, this time carefully working out all the details. Copy the example line for line, filling in the omitted steps.

8. Satisfy yourself that each step follows as a necessary result of what has gone before.

9. If there is some point that is not clear, do not puzzle over it too long but make a note of it and ask the instructor. However, hold to a minimum the points on which you must ask for help. When you work out a point for yourself, you build up your self-confidence.

10. Frequently you should be willing to work out a theory because it is interesting.

11. Review the lesson shortly before going to class.

C. How to Solve Problems

1. Assume an aggressive attitude.

2. Carefully study the theory that precedes the problems in the text or those furnished by the instructor.

3. Work the easier problems first and lead up gradually to the harder ones. If a problem is troublesome, drop it for a time and go back to it later. Make a new start so as not to repeat your former errors.

4. Write legibly. This will make for greater accuracy. Work each problem in a neat and orderly fashion.

5. Practice working accurately. If you find that you are continually making numerical errors, check over every step of the work as you go. Some people need more practice than others. It is not sufficient just to know how to do a problem; you must be able to do it accurately. At first, do not work hurriedly and under pressure. As you improve in accuracy, increase your speed.

6. Get the habit of checking the solution of the problem rather than relying upon the answer book.

7. When solving a written problem: (1) read the problem carefully; (2) state the problem in your own words; (3) let letters express

the items you wish to know; (4) state the known items; (5) write the relationships (usually equations) in terms of the known items and the letters expressing the items you wish to know, (6) solve the equation(s); (7) label your answer(s); (8) check back to the original statement and see whether your answer is reasonable.

8. Usually the first letters of the alphabet are used for constants and the last letters for variables and unknowns.

9. Remember, letters stand for numbers. If you are uncertain as to whether a certain relationship is correct, try it with numbers. (Avoid the use of 0, 1, or 2.)

D. How to Retain What You Learn

1. Mathematics is accumulative. Each course in mathematics depends upon the previous courses. Each day's work depends upon the preceding day's work. If you are to have anything worthwhile from the course, the subject matter and procedures must stay with you.

2. You must devote some of the time you have budgeted for preparation of your daily work to a review of what you have previously learned. The proportion of time to be spent depends on how much you remember. When you first review, go over all the principles and see what you have retained. The next time, go over the points in which you were weak the first time.

3. When reviewing problems, do not work on the most difficult ones. You will get tangled up in one that is extra hard and time consuming. Work several easy problems and several moderately hard ones in each set. Select those which give a variety of types.

4. Work a problem or two each day from a previous lesson under test conditions, that is, without reference to the text's discussion of that type of problem. Refer to the discussion in the text only after failure to work the problem. Repeated use of this technique will bring the course as a whole into focus and will help to give you the correct mental attitude toward the tests given in each course.

E. How to Get the Most Out of Class

1. Attend classes regularly and be on time.

2. Take part in the class discussions yourself. Learning is an active process and not a passive one. It is not sufficient to read the text or listen to the instructor.

3. Ask questions about material that bothers you. It is probably bothering someone else, too.

4. When listening to a lecture, have pencil and paper handy. Take notes on those items you wish to remember and those items you wish to check later.

5. You should go to the classroom with a determination to learn more, not merely to exhibit what you have learned.

6. The instructor will try to discover at once whether you are prepared in the fundamentals necessary to study the course.

7. The instructor will give conferences liberally. Have with you notes on specific questions you wish to ask. Be prompt to keep your appointment.

8. Examination papers will be handed back to the class and thoroughly discussed. This will let you know the types of things that are expected of you.

9. It is not the instructor's job to transmit to you the bulk of the material to be found in the textbook.

10. He will give clear explanations of the text material if it is especially involved.

11. He will frequently furnish application material in the course.

12. Frequently the instructor will use short tests to find out whether the students understand the material and which of the following remarks apply to you: (1) you are not prepared to take this course; (2) you do not study; (3) you try to study but do not know how; (4) you do not remember what you learned; (5) you are successful according to your ability; (6) you are doing satisfactory work; (7) you are doing superior work.

Your work may be better motivated if you understand the aims of freshmen mathematics. They are as follows:

To acquire an understanding of the language of mathematics.

To acquire an appreciation of the use of logical reasoning, accurate thinking, and a careful and concise way of making statements.

To acquire familiarity with the geometric forms common in nature, industry and life.

To acquire ability with the processes learned so that you can use them in other subjects where they have applications. The world needs a great many individuals who can use mathematics expertly.

To learn and appreciate the fascination of some topics of mathematics which are interesting in themselves.

If you have followed the above instructions, you should experience a feeling of satisfaction. The certainties which one finds in mathematics are pleasing to most people. The conclusions are not matters of opinion—you can know when you are right.

HIGH PRICES AND PROSPERITY

One of the foolish illusions held by many people, along with the illusion that money is real wealth, is that scarcity and high prices mean prosperity and high living standards.—Louis Bromfield, "Our Heritage, the Land."

DEVELOPMENT OF BULLETIN BOARDS IN THE ELEMENTARY SCHOOL

FRANK YOUKSTETTER
Barton Elementary School, Detroit, Michigan

There is hardly a classroom in the present day school that does not contain at least one bulletin board. Yet in our haste to incorporate and use the newer forms of visual materials, this most valuable aid is often neglected. It has been shown that children and adults naturally delight in looking at things and learn painlessly by so doing. This is the reason for the vast amount of money spent by various companies using this medium for their advertisements. Those that attract the public are simple, colorful, and of good basic design. The same principles are true of bulletin boards.

There are many and varied purposes for bulletin boards, such as:

Stimulation
Introduction to a unit
Dissemination of information
Review
Summary
Evaluation
Recording
Recognition of work well done
Decoration

A well planned board can serve as a text, workbook, data sheet, or testing device. There are usually a number of these objectives involved in the construction of any bulletin board. It must be remembered and stressed that the completion of the board, itself, should never be the ultimate goal. The board should always have a purpose. If the purpose is kept in mind a bulletin board will never become a drudgery to either the teacher or the pupils. Often bulletin boards are put up to "fill up space" and the results are very disheartening. If a board is to be worthwhile it must constantly reflect the work that is being carried on in the classroom. One of the principals commented, "One knows immediately upon entering that room what is being taught by observing the bulletin boards and displays." What a fine compliment. The bulletin board is never static. It changes with the interest of the class. Therefore, it is a questionable practice to assign bulletin boards to groups of children at the beginning of a semester. A better procedure would be to plan a board when the need arises.

Upon re-examination of the purposes of bulletin boards it becomes apparent that at times the teacher may put up the board, at other times a small group of pupils or even a single child, but most often the children and teacher will plan the board together. As the children become more adept at understanding the construction and purpose of

bulletin boards the teacher's role will become that of an advisor and his responsibility in planning the board will become less and less. If such a program is to be carried out successfully, it is important that everyone in the class understand the mechanics involved in the construction of an attractive and functional board. It is helpful to include some of the techniques of bulletin board construction and standards for evaluating a good bulletin board in a general discussion at the beginning of each new term. One fine outcome of this type of lesson is the establishment of home bulletin boards which can be a source of many hours of worthwhile leisure time activity. It is most interesting to watch students become critical of boards. In one school comprising the first through the sixth grades, some of the following remarks have been recorded:

"Why did they put up that board?
Those colors don't look 'good' together.
Those pictures are just stuck up there.
Your eye gets stuck in that corner.
Where is the punch in that?
Isn't that a good title?
Jean put a lot of work in that, I wonder if it's worth it?"

One of the most rewarding remarks was made by a first grader in referring to the room, "Oh, I could stay here all day." Children get great satisfaction out of a task well done. Activities of this nature give them a sense of belonging. The science room is most often referred to as "our room" by the children.

Backgrounds

Backgrounds of bulletin boards can be as varied as nature itself. One may use the want ad section of the daily newspaper, construction paper, display paper, newsprint, wall paper, hand painted or sprayed paper, or even leave the board uncovered and accent it with color. This accent may be any type of material—paper, cloth, metal, string, or wood. The only requirement of a background material is that it add interest to the subject displayed and that it does not detract from the materials to be mounted. Special consideration should be given to the colors used as has been previously discussed. Making backgrounds interesting and appropriate will challenge the ingenuity of any group.

A background scheme selected for all the boards in one room gives continuity and makes it appear larger. At our school a background committee is selected each month to decide upon the backgrounds for a group of boards. Interesting advertisements are examined, the important days of the month are considered. Ideas are sketched and "trial runs" are made on the two considered best. They are then criti-

cized and final selection is made. Children enjoy doing this and the ideas increase and improve as the children become more experienced. Some of the most interesting backgrounds have been the least expensive. The entire cost of six bulletin board backgrounds for one month was only 75¢. Others, of course, are more expensive but worthwhile when considering their value and attractiveness.

Color

When planning a bulletin board, color is one of the prime considerations. Colors to be used on the board should not clash with the other colors in the room. They should not be too intense for studies have shown that warm and intense colors tend to make pupils restless and nervous, while the cool and pastel colors are restful and relaxing. This should be remembered especially with reference to background materials so that the predominant features of the board will not be overshadowed. Color charts for the selection of bulletin board colors will be invaluable. Once the dominant color has been decided upon, one can quickly select matching or contrasting colors for the accent or caption. These charts save time that would otherwise be used in holding color against color to decide which is preferable. It will take very little time for the children to gain the color sense that is necessary in the construction of interesting boards. Such color charts can easily be made with the use of available construction paper from any good art book on color and design.

Form and Design

If one examines advertisements and diagrams in texts there is usually something that attracts the eye. From this point of interest the eye is led to the copy and other information the manufacturer wishes to convey. The information in the advertisement is usually brief and concerns only one product or at the most a very few. The same principles hold true for bulletin boards. There should be only one idea conveyed on a board. A focal point should be included in the planning of each board. This could be done in many ways: color, design, a picture, a specimen, or a model. Sometimes a provocative title or the covering of certain material will interest people, for everyone is inquisitive by nature. Too many objects or pictures on a bulletin board can destroy interest. It is often better to have too few pictures on a board than too many.

Balance and arrangement of a bulletin board or display is a matter of artistic sense. Pictures arranged systematically straight up and down or crosswise can become very boring. No one is attracted to such a board. It is better to group pictures in some logical order, and then arrange them in such a way that the complete board will be no-

ticed. Connecting various pictures with strips of colored paper can draw the various sections of a bulletin board together. This color will also add interest to the board.

Good ideas which are seen in other classrooms or at other schools may be roughly sketched in a looseleaf notebook for future reference. Often billboards and newspaper or magazine advertising may be the source of an idea that can be developed into a good bulletin board. Various texts will furnish the germ of a good idea for a bulletin board. Illustrations used in texts or story books offer another excellent source of ideas. Library books provide new slants on old ideas—especially books published within the last few years. Their illustrations are generally superb.

Lettering

Lettering can be done in various ways. It may be placed directly on the background with crayon, ink, or paint. This is not too satisfactory for it is impossible to use the background for another board. Also, such lettering precludes that the work must be perfect, which children's work often is not, and it allows for no rearrangement to aid in the design of the board. Letters may be cut from squares of paper or by the use of stencils. Children find it difficult to cut out letters of uniform width and size, therefore, stencils are preferable. Stencils can be purchased reasonably; often various sets can be exchanged between the teachers in the building. Another good source of inexpensive and large letters is children's A B C books.

Script writing is often interesting. This can be done by cutting around writing that has been done on a large piece of paper. Heavy yarn or cord can be used to form letters also. Smaller lettering can be done on cards free hand, with manuscript typewriter, standard typewriter, or block printing. Each kind of printing can be made interesting and effective. It is for the group to decide which is most useful in the specific instance. Lettering being difficult for the younger children, older children can cut out letters for a younger class. At other times they will want to make their own letters or take them home and have an older person cut them out for the group.

Titles

The title should indicate the purpose of the board. If the purpose of the bulletin board is to stimulate the group the caption should be one that creates interest. For example, we wanted to begin a unit on insects. To stimulate we found an article entitled "Two Billion Dollar Meal," which dealt with destruction of crops by insects. This was put up with some interesting insect pictures. The title of the board was "What to do about it?" It presented a problem, the children be-

came interested, and a worthwhile unit was started. If the board is meant for evaluation the title should provoke thought. A summation board will have as its title a statement of fact or concept learned. Titles can create interest in a board and begin critical thinking. Placement of the title is of great importance. There is no right place for all titles; it should be considered as an integral part of the board, as a part of the design.

SUMMARY

1. Bulletin boards should be used as a definite teaching device.
2. They should be used as a part of class work.
3. A bulletin board should never be static; it should constantly reflect the work of the class.
4. Since they have a variety of purposes boards may be put up by teacher and pupils working together.
5. In order to have interesting boards the teacher and pupils must have some of the fundamental skills in bulletin board construction, such as background, form and design, color, lettering, titles, and mounting.
6. Bulletin boards can add to the attractiveness of the room and really give satisfaction of accomplishment, and they are really a lot of fun.

WALTER GEORGE GINGERY RECEIVES EMERITUS LIFE MEMBERSHIP

GLEN W. WARNER
Lakeville, Indiana

The Central Association of Science and Mathematics Teachers is recognized around the world as the most progressive and influential organization of science teachers to be found on the face of the earth. To understand that this is true and not just a vain boast of one of its members let us follow it through the library reading rooms of great cities like Cleveland, Bagdad, Kyoto, Honolulu, and Chicago; from Iceland, through Cristobal, Buenos Aires, Auckland, Manila, to Fairbanks. Now we are here to honor a member who saw its prestige and further possibilities more than a third of a century ago, and freely gave his time and energy to extend its influence and good works.

More than half a century ago a group of physics teachers gathered in Chicago to organize the Central Association of Physics Teachers. Mathematics teachers saw what was done and asked to join the group. Biology teachers did the same. The result was the organization of all the basic sciences into a common, closely knit fabric, which grew and

continues to expand in scientific knowledge, mutual help, and world influence for more effective teaching.

During the years, as one after another of the special branches of this great family organized for more effective study of its own special problems, it sometimes seemed that the age of specialization would blot out the common organization. But as each member grew stronger the parent likewise increased in strength and power, so that today the Central Association stands a greater and more prosperous organization in every respect that at any time in the past—the central, unifying spirit of science education.

Just about the time this organization reached the age of maturity a young teacher from the capital city of the great state of Indiana presented a paper to the readers of the official organ of the Association entitled, "Do High School Pupils Dislike Mathematics?" It was published in October 1921. You who are now teachers of mathematics and frequently become discouraged with your results, turn back to Vol. 21 and read again pages 674 and 675.

Some years before at the little town of Copley about thirty miles to the south on August 30, 1884 a future great mathematics teacher was born. Like many others of that time he completed the work of the elementary and high schools, then began teaching in a grade school not far from home. At intervals during this early teaching experience he attended Mount Union College at Alliance and received the Bachelor of Science degree. His later teaching career includes work in the high schools of North Baltimore, Newark, and Springfield; also as Professor of Mathematics at Wittenberg College and Lecturer in Mathematics at McMaster University in Toronto, Canada. He continued his mathematics education at the University of Chicago where he was granted the degree of Master of Arts. In 1917 he moved to Indianapolis to begin work as a teacher of mathematics at the Shortridge High School. That year he also became a member of the Central Association of Science and Mathematics Teachers, and in 1924 became the custodian of its finances. From that time to the present he has been continually associated with nearly every important movement of the organization. Following his four years as treasurer he has been chairman of important committees, a director, vice-president, and president, presiding at the Milwaukee meeting in 1930. From that time to the present he has been the grand counselor for nearly every president since and has served on many of the important committees including his present important place on the Journal Committee.

In September 1927 the George Washington High School was opened in Indianapolis with our careful and influential treasurer as principal. Today, after twenty-four years, this is one of the most im-

portant of Indiana's great high schools. During this time he also served Butler University as instructor of social science and Indiana University as instructor in the Extension Division. He is a member of Phi Delta Kappa, Past President of the Central Association of Science and Mathematics Teachers, a Fellow of the Indiana Academy of Science, and has been secretary-treasurer of the Indiana Schoolmen's Club since 1945. Outside of his work as school executive and teacher he developed the U. S. Centric Air-Age Map now printed and sold by the George F. Cram Company of Indianapolis. Among his hobbies he is a student of the starry heavens and a painter of the famous Brown County scenery.

At the close of the past school year he retired from the principalship of one of the great schools of a great and progressive city to rest and enjoy the fruits of his wonderful years of activity. But rest for him is activity. Like the great hero of the Pacific an "Old Soldier Never Dies." He was called to continue the work he had never relinquished and is now located at Bloomington, Indiana, happily engaged in helping some of the great future mathematicians master the mother of all the sciences. So, fellow teachers, in your behalf, I invite Mr. Walter George Gingery to come forward to receive this scroll as a token of appreciation for years of service, to be placed among his mementos as he continues for many more years of activity among us and as he helps the girls and boys of pre-IU. Ladies and Gentlemen, Mr. Gingery.

Mr. Gingery modestly accepted the Emeritus Life Membership Certificate and stated that he had attended all annual meetings except one since he became a member. This is a record probably held by no one else.

TEACHERS CONTRIBUTE TO CHILD HEALTH*

"The school, as one of the significant agencies of the community, accepts its responsibilities for contributing to individual, family, and community health. . . . Classroom teachers in their daily contacts with boys and girls are the key persons in the school health program." These two sentences point up the theme of this bulletin.

Four phases of the school health program are discussed: (1) School Health Services, (2) Healthful School Environment, (3) Healthful School Living, and (4) Health Instruction.

This bulletin is directed primarily to teachers in-service and prospective teachers. It should be helpful also to school administrators, health coordinators, supervisors, faculty members of teacher-education institutions, and public health personnel. Parents and other interested citizens will find in it useful information and suggestions.

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* Elsa Schneider and Simon A. McNeely. Office of Education Bulletin 1951, No. 8. 44 pages. For sale by the Superintendent of Documents, U. S. Government Printing Office, Washington 25, D. C. 20 cents.

PROBLEM DEPARTMENT

CONDUCTED BY G. H. JAMISON
State Teachers College, Kirksville, Missouri

This department aims to provide problems of varying degrees of difficulty which will interest anyone engaged in the study of mathematics.

All readers are invited to propose problems and to solve problems here proposed. Drawings to illustrate the problems should be well done in India ink. Problems and solutions will be credited to their authors. Each solution or proposed problem sent to the Editor should have the author's name introducing the problem or solution *as on the following pages.*

The editor of the Department desires to serve his readers by making it interesting and helpful to them. Address suggestions and problems to G. H. Jamison, State Teachers College, Kirksville, Missouri.

SOLUTIONS AND PROBLEMS

Note. Persons sending in solutions and submitting problems for solutions should observe the following instructions.

1. Drawings in India ink should be on a separate page from the solution.

2. Give the solution to the problem which you propose if you have one and also the source and any known references to it.

3. In general when several solutions are correct, the one submitted in the best form will be used.

Late Solutions

2266. *Celia Finn, Starrett's Corners, N. Y.; Simeon Van Densen, Macon, Ga.; William Van Treese, Savannah, Ga.; Charles Solomon, Brooklyn.*

2263, 5, 6, 7, 9, 70, 71. *Ben K. Gold, Los Angeles.*

2270. *Roy E. Wild, Moscow, Idaho.*

A November Proposal

2272. *Proposed by V. C. Bailey, Evansville, Indiana.*

Prove:

$$\tan\frac{3\pi}{11}+4\sin\frac{2\pi}{11}=\sqrt{11}.$$

Solution by W. J. Cherry, Berwyn, Ill.

$$2\sin\frac{2\pi}{11}\cos\frac{3\pi}{11}+2\sin\frac{6\pi}{11}\cos\frac{3\pi}{11}+2\sin\frac{8\pi}{11}\cos\frac{3\pi}{11}+2\sin\frac{10\pi}{11}\cos\frac{3\pi}{11}+2\sin\frac{18\pi}{11}\cos\frac{3\pi}{11}$$
$$=\sin\frac{3\pi}{11}+4\cos\frac{3\pi}{11}\sin\frac{2\pi}{11}. \qquad (1)$$

This result is found by expressing products as a sum, combining terms, noting supplementary angles, etc.

Dividing both members of (1) by $\cos 3\pi/11$ we get

$$2\left(\sin\frac{2\pi}{11}+\sin\frac{6\pi}{11}+\sin\frac{8\pi}{11}+\sin\frac{10\pi}{11}+\sin\frac{18\pi}{11}\right)=\tan\frac{3\pi}{11}+4\sin\frac{2\pi}{11}. \qquad (2)$$

In order to evaluate the left member of (2) let us consider the eleventh roots of unity.

If

$$R=\cos\frac{2\pi}{11}+i\sin\frac{2\pi}{11},$$

then $R, R^2, \cdots, R^{11}$ $(R^{11}=1)$ give all the roots of $y^{11}-1=0$. From $y^{11}-1$ we remove the factor $y-1$ and conclude that $y^{10}+y^9+y^8+y^7+y^6+y^5+y^4+y^3+y^2+y+1=0$ has the roots $R, R^2, \cdots, R^{10}$. We find by the substitution of any one of the roots $R, R^2, \cdots, R^{10}$ in the above equation that

$$R^{10}+R^9+R^8+R^7+R^6+R^5+R^4+R^3+R^2+R+1=0. \tag{3}$$

Now let

$$x=R+R^3+R^4+R^5+R^9 \tag{4}$$

$$-1-x=R^2+R^6+R^7+R^8+R^{10}\ \text{(from 3)}. \tag{5}$$

Multiplying (4) by (5) we get

$$-x-x^2=5+2(R+R^2+R^3+R^4+R^5+R^6+R^7+R^8+R^9+R^{10})=5+2(-1)=3.$$

$$x^2+x+3=0. \quad R+R^3+R^4+R+R^9=x=-\tfrac{1}{2}\pm\frac{i\sqrt{11}}{2}.$$

Applying De Moivre's Theorem and equating the imaginary parts:

$$\sin\frac{2\pi}{11}+\sin\frac{6\pi}{11}+\sin\frac{8\pi}{11}+\sin\frac{10\pi}{11}+\sin\frac{18\pi}{11}=\pm\frac{\sqrt{11}}{2}.$$

We see that the positive sign is indicated, and referring to (2) we conclude that

$$\tan\frac{3\pi}{11}+4\sin\frac{2\pi}{11}=\sqrt{11}.$$

A solution was also offered by C. W. Trigg, Los Angeles City College.

2275. *Proposed by C. C. Bailey, Evansville, Indiana.*

In triangle ABC, if $1-\cos A$, $1-\cos B$, $1-\cos C$ are in harmonic progression, show that $\sin A$, $\sin B$, $\sin C$ are in harmonic progression.

Solution by Richard H. Bates, Milford, New York

To condense the notation, let sA, sB, sC be the sines of angles A, B, and C; and cA, cB, cC be the cosines of these angles.

Then if $1-\cos A$, $1-\cos B$, $1-\cos C$ are in harmonic progression

$$\frac{1}{1-cB}-\frac{1}{1-cA}=\frac{1}{1-cC}-\frac{1}{1-cB}$$

$$(1-cA)(1-cC)-(1-cB)(1-cC)=(1-cA)(1-cB)-(1-cA)(1-cC).$$

$$(1-cC)(cB-cA)=(1-cA)(cC-cB).$$

Now $\quad C=180-(A+B)\quad$ so $\quad\cos C=-\cos(A+B)$

$$\therefore\quad (1+cAcB-sAsB)(cB-cA)=(1-cA)(sAsB-cAcB-cB).$$

After simplifying, this becomes

$$s(A+B)(sA-sB)=-sA\,[s(A+B)-sB].$$

Again

$$\sin(A+B)=\sin C$$

$$sC(sA-sB)=-sA(sC-sB)$$

$$sAsC-sBsC=sAsB-sAsC.$$

Dividing each term by $sAsBsC$

$$\frac{1}{sB}-\frac{1}{sA}=\frac{1}{sC}-\frac{1}{sB}$$

which proves that sin A, sin B, sin C are in Harmonic Progression.

Solutions were also offered by Chas W. Trigg and Leon Bankoff.

2276. *Proposed by V. C. Bailey, Evansville, Indiana.*

If x, y, z are distances of centers of described circles of a triangle ABC, from center of in-circle and d is the diameter of the circumcircle, show that

$$xyz+d(x^2+y^2+z^2)=4d^3.$$

Solution by Leon Bankoff, Los Angeles, Calif.

By elementary trigonometry, if $A+B+C=180°$,

$$4\sin\frac{A}{2}\sin\frac{B}{2}\sin\frac{C}{2}+1=\cos A+\cos B+\cos C$$

which may be written:

$$4\sin\frac{A}{2}\sin\frac{B}{2}\sin\frac{C}{2}+1=\left(1-2\sin^2\frac{A}{2}\right)+\left(1-2\sin^2\frac{B}{2}\right)+\left(1-2\sin^2\frac{C}{2}\right)$$

or, more simply,

$$2\sin\frac{A}{2}\sin\frac{B}{2}\sin\frac{C}{2}+\left(\sin^2\frac{A}{2}+\sin^2\frac{B}{2}+\sin^2\frac{C}{2}\right)=1.$$

Now, it is well-known that the distances from the in-center to the three ex-centers are given by the formulas:

$$x=2d\sin\frac{A}{2}$$

$$y=2d\sin\frac{B}{2}$$

$$z=2d\sin\frac{C}{2},$$

where d is the diameter of the circumcircle. Substituting, we get:

$$2\left(\frac{x}{2d}\right)\left(\frac{y}{2d}\right)\left(\frac{z}{2d}\right)+\left(\frac{x}{2d}\right)^2+\left(\frac{y}{2d}\right)^2+\left(\frac{z}{2d}\right)^2=1$$

which, on simplifying, becomes

$$xyz+d(x^2+y^2+z^2)=4d^3.$$

A solution was also offered by C. T. Trigg and W. J. Cherry, Berwyn, Ill.

2277. *Proposed by Dwight L. Foster, Florida A & M College.*

If $s=a+b+c$, prove that

$$(as+bc)(bs+ca)(cs+ab)=(b+c)^2(c+a)^2(a+b)^2.$$

Solution by Margaret F. Willerding, Harris Teachers College, St. Louis, Mo.

If $s=a+b+c$, then

$$\begin{aligned}(as+bc)(bs+ca)(cs+ab)&=(a^2+ab+ac+bc)(b^2+ab+bc+ac)(c^2+ac+cb+ab)\\&=[a(a+b)+c(a+b)][b(a+b)+c(a+b)][c(a+c)+b(a+c)]\\&=(a+b)(a+c)(a+b)(b+c)(a+c)(b+c)\\&=(a+b)^2(a+c)^2(b+c)^2.\end{aligned}$$

Other solutions were offered by: David Rappaport, Chicago; C. W. Trigg, Los Angeles City College; Austin Koehler, Mt. Pleasant, Ia.; Oliver T. Shannon, Wheeling, W. Va.; James F. Gray, Kirkwood, Mo.; Richard H. Bates, Milford, N. Y.; Leon Bankoff, Los Angeles; George Janicki, Chicago; Robert R. Phelps, Los Angeles.

2278. *Proposed by C. W. Trigg, Los Angeles City College.*

Show that there is no scale of notation in which the three digit number, $aaa = a^3$.

Solution by the Proposer

Since $ar^2+ar+a=a^3$, then $r^2+r+1=a^2$, so

$$r=\tfrac{1}{2}[-1\pm\sqrt{4a^2-3}\,].$$

Now if the radicand is a perfect square, say N^2, then $(2a+N)(2a-N)=3\cdot 1$. The only solution of the simultaneous equations $2a+N=3$, $2a-N=1$ is $a=1$, $N=1$. Hence $r=0$ or -1, neither of which can be the base of a scale of notation.

And also a Solution by Charles McCracken, Jr., Cincinnati

Let r denote the base.

$1\leqq a\leqq r-1.$

$ar^2+ar+a=a^3.$

$r^2+r+1=a^2.$

$r<a\leqq r-1.$

$r<r-1.$ Contradiction.

This completes the proof.

Leon Bankoff, Los Angeles and Martin Hirsch, Brooklyn also offered solutions.

2279. *Proposed by Norman Anning, Univ. of Michigan.*

In triangle P_1, P_2, P_3, r is radius of incircle, also r_1, r_2, r_3 are radii of excircles inside angles P_1, P_2, P_3 respectively. Show that the following relations hold:

If

$$P_3=60^\circ, \quad 3r_3=3r+r_1+r_2 \quad \text{and} \quad 3rr_3=r_1r_2$$

and if

$$P_3=90^\circ, \quad r_3=r+r_1+r_2 \quad \text{and} \quad rr_3=r_1r_2$$

also if

$$P_3=120^\circ, \quad r_3=r+3r_1+3r_2 \quad \text{and} \quad rr_3=3r_1r_2.$$

Solution by Leon Bankoff, Los Angeles, Calif.

It is well-known that

$$r_1=s\left(\tan\frac{P_1}{2}\right),$$

$$r_2=s\left(\tan\frac{P_2}{2}\right),$$

$$r_3=s\left(\tan\frac{P_3}{2}\right),$$

where s is the semi-perimeter of triangle $P_1P_2P_3$.

By the familiar relation,

$$\frac{1}{r}=\frac{1}{r_1}+\frac{1}{r_2}+\frac{1}{r_3},$$

we get

$$r=s\left(\tan\frac{P_1}{2}\tan\frac{P_2}{2}\tan\frac{P_3}{2}\right).$$

a) If $P_3=60°$,

$$\tan\frac{P_3}{2}=\frac{\sqrt{3}}{3} \quad \text{and} \quad \cot\frac{P_3}{2}=\sqrt{3}.$$

b) Then,

$$\begin{aligned}3\tan\frac{P_3}{2}&=\cot\frac{P_3}{2}\\&=\tan\left(\frac{P_1}{2}+\frac{P_2}{2}\right)\\&=\frac{\tan\frac{P_1}{2}+\tan\frac{P_2}{2}}{1-\tan\frac{P_1}{2}\tan\frac{P_2}{2}}.\end{aligned}$$

Hence

$$3\tan\frac{P_3}{2}=\tan\frac{P_1}{2}+\tan\frac{P_2}{2}+3\tan\frac{P_1}{2}\tan\frac{P_2}{2}\tan\frac{P_3}{2}.$$

Or,

$$\frac{3r_3}{s}=\frac{r_1}{s}+\frac{r_2}{s}+\frac{3r}{s}.$$

And

$$3r_3=3r+r_1+r_2.$$

Also

$$\begin{aligned}3rr_3&=3s^2\left(\tan\frac{P_1}{2}\tan\frac{P_2}{2}\tan\frac{P_3}{2}\right)\left(\tan\frac{P_3}{2}\right)\\&=3s^2\left(\tan\frac{P_1}{2}\tan\frac{P_2}{2}\right)\left(\tan^2\frac{P_3}{2}\right).\end{aligned}$$

From *b*)

$$3\tan^2\frac{P_3}{2}=1.$$

Hence

$$\begin{aligned}3rr_3&=s^2\left(\tan\frac{P_1}{2}\tan\frac{P_2}{2}\right)\\&=r_1r_2.\end{aligned}$$

c) If $P_3=90°$,

$$\tan\frac{P_3}{2}=1.$$

Then,

$$\tan\frac{P_3}{2}=\tan\left(\frac{P_1}{2}+\frac{P_2}{2}\right)$$

$$= \frac{\tan \frac{P_1}{2} + \tan \frac{P_2}{2}}{1 - \tan \frac{P_1}{2} \tan \frac{P_2}{2}}.$$

Hence

$$\tan \frac{P_3}{2} = \tan \frac{P_1}{2} + \tan \frac{P_2}{2} + \tan \frac{P_1}{2} \tan \frac{P_2}{2} \tan \frac{P_3}{2}.$$

Or,

$$\frac{r_3}{s} = \frac{r_1}{s} + \frac{r_2}{s} + \frac{r}{s}.$$

And,

$$r_3 = r + r_1 + r_2.$$

Also,

$$rr_3 = s^2 \left(\tan \frac{P_1}{2} \tan \frac{P_2}{2} \tan \frac{P_3}{2} \right) \left(\tan \frac{P_3}{2} \right)$$

$$= s^2 \left(\tan \frac{P_1}{2} \tan \frac{P_2}{2} \right)$$

$$= r_1 r_2.$$

d) If $P_3 = 120°$,

$$\tan \frac{P_3}{2} = \sqrt{3} \quad \text{and} \quad \cot \frac{P_3}{2} = \frac{\sqrt{3}}{3}.$$

Then,

$$\tan \frac{P_3}{2} = 3 \cot \frac{P_3}{2}$$

$$= 3 \tan \left(\frac{P_1}{2} + \frac{P_2}{2} \right)$$

$$= 3 \left\{ \frac{\tan \frac{P_1}{2} + \tan \frac{P_2}{2}}{1 - \tan \frac{P_1}{2} \tan \frac{P_2}{2}} \right\}$$

$$\tan \frac{P_3}{2} = \tan \frac{P_1}{2} \tan \frac{P_2}{2} \tan \frac{P_3}{2} + 3 \tan \frac{P_1}{2} + 3 \tan \frac{P_2}{2}.$$

Or,

$$\frac{r_3}{s} = \frac{r}{s} + \frac{3r_1}{s} + \frac{3r_2}{s}.$$

And

$$r_3 = r + 3r_1 + 3r_2.$$

Also,

$$rr_3 = s^2 \left(\tan \frac{P_1}{2} \tan \frac{P_2}{2} \tan \frac{P_3}{2} \right) \left(\tan \frac{P_3}{2} \right)$$

$$=s^2\left(\tan^2\frac{P_3}{2}\right)\left(\tan\frac{P_1}{2}\right)\left(\tan\frac{P_2}{2}\right)$$

$$=3r_1r_2.$$

Chas. W. Trigg and Richard Bates, Milford, N. Y. also offered solutions.

EDITOR'S NOTE: The relation

$$r=s\left(\tan\frac{P_1}{2}\tan\frac{P_2}{2}\tan\frac{P_3}{2}\right)$$

will be offered as a problem to be solved later on.

2280. *Proposed by Norman Anning, Univ. of Michigan.*

Using the same notation as in 2279, find angle P_1, if $2r_1=2r+r_2+r_3$.

Solution by Leon Bankoff, Los Angeles, Calif.

$$2s\left(\tan\frac{P_1}{2}\right)=2s\left(\tan\frac{P_1}{2}\tan\frac{P_2}{2}\tan\frac{P_3}{2}\right)+s\left(\tan\frac{P_2}{2}\right)+s\left(\tan\frac{P_3}{2}\right).$$

Regrouping and factoring:

$$2\tan\frac{P_1}{2}\left(1-\tan\frac{P_2}{2}\tan\frac{P_3}{2}\right)=\tan\frac{P_2}{2}+\tan\frac{P_3}{2}$$

$$2\tan\frac{P_1}{2}=\frac{\tan\frac{P_2}{2}+\tan\frac{P_3}{2}}{1-\tan\frac{P_2}{2}\tan\frac{P_3}{2}}$$

$$=\tan\left(\frac{P_2}{2}+\frac{P_3}{2}\right)$$

$$=\cot\frac{P_1}{2}$$

$$=\frac{1}{\tan\frac{P_1}{2}}.$$

Or,

$$2\tan^2\frac{P_1}{2}=1.$$

Hence

$$\frac{P_1}{2}=\text{arc tan } .7071=35°16' \text{ (approximately)}$$

and $P_1=70°32'$ (approximately).

Chas. W. Trigg and Richard H. Bates also offered solutions.

HIGH SCHOOL HONOR ROLL

The Editor will be very happy to make special mention of high school classes, clubs, or individual students who offer solutions to problems submitted in this department. Teachers are urged to report to the Editor such solutions.

Editor's Note: For a time each high school contributor will receive a copy of the magazine in which the student's name appears.

2266. *Arthur Anderson, Lindblom H. S., Chicago.*

2270. *Bruno D. Corobbo, Skokie, Ill.*

2277. *Fran Barnes, Louie Phillips, Nick Wilson, all from George Washington High School, San Francisco 21, Calif.; Warren Fellingham, Jim Stenborg, Alan Dieball, Louis Barkhausen and Joan Timmermann—all of Arlington Heights, Ill., Township H. S.*

PROBLEMS FOR SOLUTION

2293. *Proposed by V. C. Bailey, Evansville, Ind.*

Three circles whose radii are a, b, c touch each other externally. Prove that the radii of the two circles which touch the three circles are in

$$\text{length} = \frac{abc}{(ab+ac+bc) \pm 2\sqrt{abc(a+b+c)}}.$$

2294. *Proposed by Charles McCracken, Cincinnati, Ohio.*

If the arc of a circle is 20 and the chord is 16, find the radius.

2295. *Proposed by C. W. Trigg, Los Angeles City College.*

D-ABC is a regular tetrahedron and P is any point on the surface of the inscribed sphere. Show that $(PA)^2+(PB)^2+(PC)^2+(PD)^2$ is a constant.

2296. *Proposed by Hugo Brandt, Chicago.*

If the area of a spherical regular quadrilateral with all angles equal and all sides equal to 1 degree, is called a "square degree," how many "square degrees" are contained in area of the surface of the sphere?

2297. *Proposed by Cecil B. Reed, Wichita, Kan.*

Prove that

$$8\left(\sin\frac{\pi}{7}\right)\left(\sin\frac{2\pi}{7}\right)\left(\sin\frac{3\pi}{7}\right) = \sqrt{7}.$$

2298. *Proposed by Norman Anning.*

The sides of a possible triangle are in arithmetical progression. Show that, with one trivial exception, the intermediate angle is less than 60°.

METALLIC LENS ANTENNA AIDS LONG-DISTANCE TV TRANSMISSION

A metallic lens antenna, one of the type that now makes it possible to send television programs across the continent, is among the total of 821 inventions on which patients were awarded by the government this week. Lenses of this type gather up scattering radio waves falling on them and focus them into a beam which may be amplified and directed on to the next relay station.

Inventor is Winston E. Kock, Middletown, N. J., and the patent received was number 2,576,463. Rights have been assigned to Bell Telephone Laboratories, Inc., New York City.

Lenses of this type consist of a series of thin flat metal plates standing on edge and extending in the direction of the wave transmission.

Front and rear of the parallel plates are trimmed so that their edges define a curved surface. As described by the inventor, in this lens one of the sides has in a given plane an elliptical contour, and the other side has in a plane perpendicular to the first a hyperbolic contour.

BOOKS AND PAMPHLETS RECEIVED

EVERYDAY WEATHER AND HOW IT WORKS, by Herman Schneider, *Supervisor of Science, Elementary Schools of New York City.* Cloth. 189 pages. 13×20.5 cm. 1951. Whittlesey House, McGraw-Hill Book Company, Inc., New York, N. Y. Price $2.75.

LOGIC FOR LIVING, LECTURES OF 1921–22, by Henry Horace Williams, *University of North Carolina.* Cloth. Pages xix+281. 13.5×21.5 cm. 1951. Philosophical Library, Inc., 15 East 40th Street, New York 16, N. Y. Price $3.75.

MATHEMATICS FOR TECHNICAL STUDENTS, Book III, by J. D. N. Gasson, M.A., B.Sc., *Senior Lecturer in Mathematics, Chesterfield Technical College.* Cloth. Pages xi+451. 13.5×21.5 cm. 1951. Cambridge University Press, American Branch, 51 Madison Avenue, New York 10, N. Y. Price $3.50.

DISCOVERING PHYSICS, by Harold P. Knauss, *Head of Department of Physics, University of Connecticut.* Cloth. 454 pages. 18×24 cm. 1951. Addison-Wesley Press, Inc., Kendall Square, Cambridge 42, Mass. Price $6.00.

REFERENCE BOOK OF INORGANIC CHEMISTRY, Third Edition, by Wendell M. Latimer, *Professor of Chemistry in the University of California,* and Joel H. Hildebrand, *Professor of Chemistry in the University of California.* Cloth. Pages xii+625. 13.5×21 cm. 1951. The Macmillan Company, 60 Fifth Avenue, New York 11, N. Y. Price $5.00.

AN INTRODUCTION TO APPLIED MATHEMATICS, by J. C. Jaeger, *Professor of Applied Mathematics in the University of Tasmania.* Cloth. Pages xiii+445. 13.5×21.5 cm. 1951. Oxford University Press, 114 Fifth Avenue, New York 11, N. Y. Price $7.00.

GENERAL EDUCATION IN SCIENCE, Edited by I. Bernard Cohen and Fletcher G. Watson with a Foreword by James Bryant Conant. Cloth. Pages xviii+217. 13.5×21 cm. 1952. Harvard University Press, Cambridge 38, Mass. Price $4.00.

HANDBOOK OF BASIC MICROTECHNIQUE, by Peter Gray, Ph.D., D.I.C., *Head, Department of Biological Sciences, University of Pittsburgh.* Cloth. Pages viii+141. 15×23 cm. 1952. The Blakiston Company, Philadelphia 5, Pa. Price $3.00.

CHEMISTRY IN ACTION, Second Edition, by George M. Rawlins, *Professor of Chemistry, Austin Peay State College, Clarksville, Tennessee, Formerly Head of the Department of Science, Public Schools of the District of Columbia, Divisions I–IX,* and Alden H. Struble, *Teacher of Science, Western High School, Washington, D. C.* Cloth. Pages vi+575. 16×23.5 cm. 1952. D. C. Heath and Company, 285 Columbus Avenue, Boston 16, Mass. Price $3.60.

ELIAS E. RIES, INVENTOR, by Estelle H. Ries. Cloth. Pages xii+369. 13×21.5 cm. 1951. The Philosophical Library, Inc., 15 East 40th Street, New York 16, N. Y. Price $4.75.

NORTH OF THE CIRCLE, by Frank Illingworth. Cloth. 254 pages. 13.5×21.5 cm. 1952. The Philosophical Library, Inc., 15 East 40th Street, New York 16, N. Y. Price $4.75.

THE BATTLE FOR MENTAL HEALTH, by James Clark Moloney, M.D., *Birmingham, Michigan.* Cloth. Pages x+105. 12.5×19.5 cm. 1952. The Philosophical Library, Inc., 15 East 40th Street, New York 16, N. Y. Price $3.50.

FIRST YEAR COLLEGE CHEMISTRY, by John W. Barker, *Professor of Chemistry, Wittenberg College,* and Paul K. Glasoe, *Professor of Chemistry, Carthage College.* Cloth. Pages x+501. 14.5×23 cm. 1951. McGraw-Hill Book Company, Inc., 330 W. 42nd Street, New York 36, N. Y. Price $5.00.

LABORATORY MANUAL FOR FIRST YEAR COLLEGE CHEMISTRY, by John W. Barker, *Professor of Chemistry, Wittenberg College*, and Paul K. Glasoe, *Professor of Chemistry, Carthage College*. Paper. Pages xi+186. 21×28 cm. 1951. McGraw-Hill Book Company, Inc., 330 W. 42nd Street, New York 36, N. Y. Price $3.00.

INVENTORIES OF APPARATUS AND MATERIALS FOR TEACHING SCIENCE. Volume III, Technical Colleges, Part 3, Agricultural Sciences. Paper. 139 pages. 15.5 ×24 cm. 1951. Publication No. 839. United Nations Educational, Scientific and Cultural Organization, 19 Avenue Kléber, Paris, France.

FIRST SUPPLEMENT, RECEIVING TUBE SUBSTITUTION GUIDE BOOK, by H. A. Middleton. Paper. 44 pages. 21×28 cm. 1951. John F. Rider Publisher, Inc., 480 Canal Street, New York 13, N. Y. Price 99 cents.

THE THEORY OF THE MICROSCOPE, by James R. Benford, *Head of the Microscope and Telescope Department, Bausch and Lomb Optical Company*. Paper. 20 pages. 15.5×23 cm. 1951. Bausch and Lomb Optical Company, Dept. FF-1, Bureau of Education, Rochester 2, N. Y.

WESTINGHOUSE LABORATORY APPARATUS CATALOGUE 190. 64 pages. 21×28 cm. Westinghouse Electric Corporation, Box 2099, Pittsburgh 30, Pa.

STRONG DOLLARS. Report by Eric Johnston, *Administrator, Economic Stabilization Agency*. 39 pages. 19.5×26 cm. November 30, 1951. Superintendent of Documents, U. S. Government Printing Office, Washington 25, D. C. Price 25 cents.

THE BATTLE FOR PRODUCTION, by the *Director of Defense Mobilization*, Charles E. Wilson. Paper. Pages iv+52. 20×26 cm. January 1, 1952. Superintendent of Documents, U. S. Government Printing Office, Washington 25, D. C. Price 35 cents.

BOOK REVIEWS

200 MILES UP—THE CONQUEST OF THE UPPER AIR, by J. Gordon Vaeth, *Aeronautical Engineer, U. S. Navy Special Devices Center, Office of Naval Research*. Cloth. Pages xiii+207. 15×23 cm. 1951. The Ronald Press Company, 15 East 26th Street, New York 10, N. Y. Price $4.50.

This book is an interesting scientific account of upper air research. It starts with the beginning of investigations into the upper atmosphere, first made by balloon flights about a century and a half ago, and comes down to the present time of research with the V-2 or German type of rocket, the Aerobee or Applied Physics Laboratory rocket, the The Naval Research Laboratory's Viking. The atmospheric ocean is well discussed and will be read with interest by everyone. The various regions are explained, the methods of investigation, temperature, pressure, and auroral lights fill important sections. Other factors described and explained, when possible, are the ionization characteristics, meteoric flights, high altitude clouds, winds of the upper air, and the atmosphere's ceiling. The many instruments used to make the needed investigations of all these factors, their storing in the rocket's head, and recovery after flight make up an interesting chapter. Each of the vehicles used to carry the investigating instruments has both advantages and limitations: rockets rise to great heights but the space for instruments is limited and their recovery unharmed is always questionable; balloons rise to fair heights, carry fair size loads, time for investigation is much greater than with rockets, but recovery is likewise a question involving doubt; airplanes carry great loads, are completely under control in all normal flights, investigations are carried on through long periods under direct observation, but the

height is limited. All these factors are well discussed and illustrated. The laboratory for the many experiments is the White Sands Proving Ground on the New Mexico desert. This installation and the region surrounding it are described in detail and the experiments with V-2's are thoroughly discussed. As much of the data on the flights of the Aerobee and the Viking is still top secret only a short chapter is given to each. This book contains so much that is new, and all will be valuable as time goes on, that it should be in every school and public library. Excellent illustrations and photographs are in great numbers.

G. W. W.

ATOMIC ENERGY IN WAR AND PEACE, by Captain Burr W. Letson. Cloth. Pages 217. 31 photo-illustrations and 24 graphs and diagrams. 14×19.5 cm. 1951. E. P. Dutton & Co., New York. $3.75.

This book might appropriately fit into a trilogy including Bradley's "No Place to Hide," Lapp's "Must We Hide?" and Letson's (Retitled) "How We May Hide." That rephrase of the book's title very well briefs the major impression it makes upon the reader.

However, there are other contributions of merit in its pages. Its concise but explicit account of what atoms are made of and what happens when they explode is very well done for the non-technical reader. Its catalogue and account of the current types of accelerators for atomic particles is unique for the publications of this trilogy. Even the chapter on the hydrogen-bomb, while somewhat superficial and more given to polemics than to exposition is welcome in all its brevity.

Captain Letson's previous service in preparing World War II's "Air Raid Safety Manual" is in evidence to the reader as he follows the clear and detailed exposition of how to go about civilian defense against A-Bomb destruction. One authoritative critic says, "No other book . . . matches this for thoroughness and accuracy on this subject."

One chapter, "Atomic Energy in Medicine and Industry," less than one tenth of the book's pages, gives rather scant recognition to atomic energy in peace. This is understandable in that the author is by training and background a military man.

A four page glossary, its splendid photo illustrations and a creditable index facilitate the book's ready use by informed laymen who may find it very much to be desired in their program for civilian defense.

B. CLIFFORD HENDRICKS,
Longview, Washington

STATISTICAL METHODOLOGY REVIEWS 1941–1950, Edited by Oscar Krisen Buros, *Director, Institute of Mental Measurements, School of Education, Rutgers University.* Cloth. Pages x+457. 19×27 cm. 1951. John Wiley and Sons, Inc., 440 Fourth Avenue, New York 16, N. Y. Price $7.00.

This is the third volume in a series originally planned to be published once every two years. Unfortunately, since the appearance of the previous volume (*The Second Yearbook of Research and Statistical Methodology Books and Reviews*) many more than two years have elapsed. The present volume is limited to books on statistical methods and closely related subjects, thus providing a narrower coverage.

The book lists 342 books published or reviewed in the period covered. For each book bibliographic information, including publisher and price, is given. For a major portion of the books listed, there are excerpts from one to twelve or more reviews. Although it has been necessary to shorten such reviews, omissions seem to have been clearly indicated, and a statement would imply that omitted material is nonevaluative. There are several valuable indexes, for example, an index of publishers; an index of titles; an index of names; an index of books roughly classified by subject matter.

The librarian desiring to make a selection between two or more books of es-

sentially the same nature will find the material very valuable. The instructor wishing to select a textbook may find some confirmation of his own judgment (or perhaps the reverse). Unfortunately, information available in this volume should have been available some time ago with respect to a book published in 1941 or 1942 in order that the information may be of greatest value.

Unquestionably the volume is of great value as a labor saving device. Even if all the periodicals from which reviews are excerpted were available (certainly not true in many small libraries) it would take a great deal of time to locate the reviews desired.

It is to be hoped that publication of this series will continue, but with a shorter time lapse. In view of the reduction in scope of the present volume, it is perhaps useless to hope for the inclusion of reviews of books in foreign languages. One also wonders why there are so many cases where only a single review of a book is excerpted. It is quite possible that only one review has appeared; if this is not the case it is doubtful if very extended consideration of a few books (even if these are of outstanding importance) balances the objection of giving only a single review or no review of others. This point is emphasized by the fact that one book has about 23 pages devoted to it, another sixteen pages, at least two with seven or eight pages; on the other hand there are several books with a single review given, and less than 25 lines. In fairness to the editor, however, it would seem that in general the space assigned has some relationship to the importance of the book.

CECIL B. READ
University of Wichita

INTRODUCTION TO NUMBER THEORY, by Trygve Nagell, *Professor of Mathematics, University of Uppsala, Sweden.* Cloth. 309 pages. 15×23 cm. John Wiley and Sons, Inc., 440 Fourth Avenue, New York 16, N. Y. Price $5.00.

In general a book on number theory would fall in one of three classifications: a college text, a reference book, or a book for the general reader. Although the author seems to imply this might be of value to the general reader, it seems to the reviewer that it would probably more properly be classified as a reference book. It is not in the style of the usual undergraduate college text. Particularly the exercises or problems which occur at the end of the chapters seem to be extension of general results, rather than routine in nature. Technically the earlier portion of the book can be read with someone who has only college algebra. Actually someone with this background will find himself sadly at a loss in many places for a considerable amount of mathematical maturity is needed.

The book contains a large number of new results and methods, and from this point of view would be exceptionally valuable as a reference book. For someone wanting unusual material for mathematics club programs there are several good sources in this text. For example: the discussion of lattice points, the proofs of the irrationality of the numbers e and pi. Beginning students may be interested in the method of the attack of the theorem "the product of n consecutive integers is divisible by $n!$"

Possibly some individuals might find the book suitable as a text. More likely it will find its place as a reference book in college and university libraries. It is doubtful if many people would benefit from having the book in a high school library or even in a public library, other than in a large city. The general reader will be frightened away from reading the book by the mathematical symbolism with which he is not familiar.

CECIL B. READ

EVERYDAY ARITHMETIC, Junior Books I and II, by Harl R. Douglass, *Director, College of Education, University of Colorado;* Lucien B. Kinney, *Professor of Education, Stanford University;* and Donald W. Lentz, *Principal, Ridge Road School, Parma, Ohio.* Cloth. Book I, ix+488 pages, Book II, ix+502 pages. 1950. 13×20.5 cm. Henry Holt and Company, 257 Fourth Avenue, New York 10, N. Y. Price $2.08.

This series for the mathematics work in the seventh and eighth grades does not impress one as being merely a revision of the earlier series by Douglass and Kinney. It includes all the topics usually covered in most junior high texts, whole numbers, fractions, decimals, percentage and applications, and measurement and geometry. In relating these topics to everyday-life problems, the authors have been ingenious. The last chapters of Book 2 are especially fine in this respect and the relationships between these problems and the work of the preceding units is well defined.

Many diagrams and illustrative examples are employed to help increase understandings of number ideas and processes and there are sufficient exercises included to show applications and provide drill where the occasion might require it. Most sections are very good in this respect having an abundance of good problems with some of more difficulty for pupils capable of more than average achievement. The work in percentage is well developed in both texts but one might wish that the formula method were applied to the "three cases" in the seventh grade text as well as in the eighth and that the so-called "third case" examples were not listed as optional topics. The material on ratio and proportion in Book 2 follows logically the construction of congruent and similar triangles.

The sections on rounding off and approximate numbers are clearly treated, some fine illustrations being given. Book 2 even includes a short section on significant figures and operations involving approximate numbers, a topic not usually mentioned in texts for these years. However, this latter material might have been made more meaningful if more attempt had been made to relate it to the preceding and following topics which involve computations with pi.

There are many new features that should be welcome and useful to both teachers and pupils. In addition to the complete index in the back of each text there is a quick reference table inside the front cover telling where extra "workouts" and tests can be found which involve the fundamental operations with whole numbers, fractions, money, decimals, and percentage. Easily located inside the back cover are listed the tables of measure. The last section of each text is given over to "Extra Workouts, when you need them" which provide more drill material and include illustrative examples for self help.

Teachers interested in securing a fine basic text for junior high use would do well to examine this series carefully.

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MATHEMATICS FOR TECHNICAL STUDENTS, by J. D. N. Gasson, *Senior Lecturer in Mathematics, Chesterfield Technical College.* Table of Contents. Index. Four-place log. and trig. tables. Cloth. Pages x+431. 1951. Cambridge, at the University Press.

There is a faint suggestion in the title of this book that the mathematics which technical people use is a rather special kind. It is a bit ironical perhaps that mathematics, like the fabled pigs, exhibits a stubborn integrity and remains mathematics in whatever garb it is dressed. The entire course of study set forth in the present volume is traditional in its conception. The author selects and arranges—and that very ably—the material at his disposal, and gives to the old generalities a local habitation and a name. The raising of the jib of a crane, for instance, affords a problem involving the sine ratio; the formula for the period of oscillation of a pendulum leads to a problem in quadratics; the height of a projectile introduces a problem in trigonometry; the stretching of an elastic string gives rise to a problem in integration. It is true, of course, that the conventional textbook frequently contains problems of this type; and it is also true that the present volume stresses "the analytical type of problem favoured by public examining boards and essential to the development of mathematical skill."

The author states that it is the aim of the book "to provide a complete course in mathematics for the second year of the National Certificate in Mechanical,

Structural, and Electrical Engineering." *Complete* is a bold word to use in describing any mathematics course, but it is surprising that so much matter could be included in the four hundred pages that make up the book—a kind of correlated treatment of algebra, geometry, trigonometry, analytic geometry and calculus. The text is divided into two parts; and these, the author says, should be worked concurrently, "for at certain stages the two parts deal with the same topic from different points of view." The chapters are in the same pattern: there is a discussion; then there are illustrative examples, problems to be worked, and answers at the end of the chapter.

The algebraic portions of the book include the rudiments of a first-year college course, with highly involved manipulative exercises being conspicuously absent. The trigonometry, interspersed where needed, will be found to be considerable. The chapter on "Heights and Distances" is exceptionally good, and some of the problems involving three dimensions are intriguing. Expert drawings in which parts are shaded to indicate whether they are in vertical or horizontal planes help the student to visualize a situation. Solid geometry appears in the chapter on mensuration, where important formulas for areas and volumes are given without proof. This section is followed by a chapter on the mid-ordinate rule and Simpson's rule for finding approximate areas.

Very little attempt is made to examine critically the theoretical aspects of analytic geometry, the emphasis being on the recognition of equations and verification by graphing. It is interesting to note that the space given to analytic geometry is slightly less than that given to pure geometry, where chapters on "Geometry of Angles in Circles," "Similar Triangles," "Geometry of Tangents to Circles," and "Triangles and Circles" attest the importance attributed to this phase of mathematics.

The calculus, compressed into four chapters, can hardly give the student great insight into this tremendous field; but he does gain some experience in differentiating algebraic functions from first principles and by rule and in attacking problems involving maxima and minima, velocity, and acceleration, in addition to the type of problem dealing with the tangent and the normal. In a single chapter on integration the student is introduced to the method of determining areas.

The book is excellent in format, clear and adequate in its explanations, conscionable to the situations in which "some difficulty is experienced by students." Where so much territory is covered there are necessarily some curtailments. While observing that trigonometric identities are "vitally important in the simplification of lengthy expressions," the author provides very few exercises for practice. Likewise the numerous practice exercises found in most algebra textbooks are wanting. The student must therefore be his own taskmaster. The analytical type of problem, in which he appraises a new situation and brings to bear on it the necessary machinery, presupposes a measure of maturity and fosters the kind of development which mere drill could never achieve.

The book will make an admirable addition to any teacher's library and will be particularly interesting to those concerned with the correlated type of course.

W. J. CHERRY
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BRIEF COURSE IN ANALYTICS, Revised Edition, by M. A. Hill, Jr., and J. B. Linker, *University of North Carolina.* Cloth. Pages xi+224. 14×20 cm. 1951. Henry Holt and Company, Inc., New York, N. Y. Price $2.40.

The authors have done a good job in selecting the essentials of analytics for a three hour course. The definitions of the ellipse and hyperbola in terms of the sum and difference of the distances from the foci seems well adapted to a brief course, since the general definition of a conic is given at the end of the chapter. The early introduction of translation and the inclusion of such parametric equations as the cycloid is to be commended. The design on the cover indicates that graphing by composition of ordinates is included.

The exposition of the theory is very readable, and on the whole adequate, if the student masters each assignment before starting the next topic. But the first time the algebraic process of completing the square is mentioned (page 46) it should have been explained in detail. It is too bad that a word of warning is not given about parametric equations not always being fully equivalent to the rectangular equation secured by eliminating the parameter. One of the exercises is to draw the curve represented by the equations

$$x=4\cos^4\theta, \qquad y=4\sin^4\theta.$$

This is only a portion of the parabola

$$(x-y)^2-8(x+y)+16=0$$

secured by eliminating θ.

The exercises are adequate in quantity. They seem to be well graded, so as to encourage the student at first, and yet challenge him to do some rigorous thinking in applying his knowledge before the assignment is completed. Algebraic generalization in the exercises is started early (page 17) but on the whole this reviewer feels there should be a greater number of such exercises. I did not notice any exercises where a discussion of various cases was required. Graphing such an equation as

$$(x-1)(x-2)y=2x-3$$

by plotting points seems to be a waste of time. Indeed it would be difficult to sketch after reading the discussion on analyzing an equation, as none of the examples given are beyond the quadratic type.

A few minor errors might be mentioned. "Knots an hour" (page 18) is a common error since most landlubbers do not know that a knot is a measure of speed. It should be "nautical miles per hour" or "knots." In the chapter on solid analytics the statement is made that a projecting plane is perpendicular to one of the coordinate axes. It is of course perpendicular to one of the coordinate planes, and parallel to an axis. In the same chapter the singular term "equation of a line" is used, while the section headings used the customary plural term "equations of a line."

For those schools giving a three hour course, this text should be considered, rather than trying to eliminate topics from a more complete text.

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THE RESTLESS UNIVERSE, by Max Born. Figures by Dr. Otto Koenigsberger. Authorized Translation by Winifred M. Deans. Second edition revised 1951. 120 drawings and figures. 11 pages of photographs. Almost 1,000 illustrations. 3 tables. 352 pages. 6×9 approx. Dover Publications, New York. $3.95.

I met this book the year it was first published (1936) and I have read it at least four times from cover to cover and I have referred to it here and there a dozen times or more. It is this kind of a book. If once you take it up it is not easily put down. This was true of the first edition and doubly so for this revised issue which bears a significant *postcript.*

The contents are in five chapters:

1. The Air and Its Relatives
2. Electrons and Ions
3. Waves and Particles
4. The Electronic Structure of the Atom
5. Nuclear Physics

following which is the Postscript.

The page margins are uniquely equipped with repetitious diagrams which show the "restlessness" of the universe when the pages are flicked over with the thumb—essentially a motion picture. The discourse is eminently palatable for

those versed or not in physics. It reads in a very friendly fashion and puts the reader on intimate terms with the author and with the material. Of the author we need say little. Max Born is of international renown, in both physics and mathematics. His education is classical—Breslau, Heidelberg, Zurich, Göttingen, Cambridge. He was for a time Stokes Lecturer in Mathematics at Cambridge. He is now at Edinburgh. Most of his contributions have been in the higher flights of physics and mathematics on such topics as Relativity, Atomic Dynamics, Quantum Mechanics, and so on. In this volume he talks to the layman with the ambition of conveying and interpreting some of the wonders of this Creation. That he has succeeded is seen at once when the book is taken up.

The *Postscript* multiplies the value of this little volume severalfold. Herein he deals with such issues as our technical progress measured against the total welfare of men; the social responsibilities of the physical scientist; political fission and nuclear fusion—the tragic fusion of physics and politics—and finally Paradise or Hell! He closes with a section titled *Outlook* which must be read.

This book would make an ideal birthday gift for all intelligent people. Its contents are everlasting.

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LITTLE SCIENCE BOOKS FOR BIG AND LITTLE PEOPLE

GLEN W. WARNER

OBSERVING THE HEAVENS, by Peter Hood. Cloth. 64 pages. 17×23.5 cm. 1951. Oxford University Press, 114 Fifth Avenue, New York 11, N. Y. Price $1.75.

This is an excellent book for starting the study of our oldest science. The frontispiece is a copy of an old chart of the northern heavens with the constellations of the Zodiac around the edge. Two beautiful star maps, white on blue background, show on two double pages the equatorial heavens; the principal constellations are outlined and the largest stars named. A few important nebulae are located and named, as M 31, the Great Nebula. Other similar charts show the northern heavens and the southern heavens. Many other smaller charts show the solar system, the apparent movements of Jupiter, and the apparent path of the sun. Approximately a page is given to each of the following: comets, meteors, double and variable stars, star clusters, the nebulae, the Galaxy, and other galaxies.

The book was originally written for students of the British Isles and contains a few references and directions for observers living there, but this will cause little difficulty for students in other parts of the world.

BILLY BASS, by R. W. Eschmeyer. Cardboard. 47 pages. 12×17 cm. 1951. The Fisherman Press, Inc., Oxford, Ohio.

Billy Bass is a wonderful little book for all conservationists, and that should mean that it is for you. The story is the life of a fish, how he lived and grew up. Once he got far up a stream that was carrying away all the rich top soil, and another time he swam into a stream that carried the sewage from a town and the acid from factories. But later on the people began to get wise. The farmers introduced modern methods of farming and the city people built a sewage disposal plant. All this made life a paradise for the next generations of Billy, and also gave the kids of all ages clear, clean water for fishing and swimming, and helped both the farmers and their city neighbors to prosperity and contentment.

PATTERNS IN THE SKY, by W. Maxwell Reed. Cloth. 125 pages. 15.5×21.5 cm.

1951. William Morrow and Company, Inc., 425 Fourth Avenue, New York 16, N. Y. Price $2.50.

This is a first book for those who want to know about the stars. Its nineteen chapters help the beginner to learn all the great constellations and their important stars. Two illustrations are used in each chapter. One is a picture of the mythological hero for whom the constellation is named and the other is the black background sky showing the important stars of the group. In all twenty-five of the most familiar constellations are described and the mythological stories of them are told.

STATE BIRDS AND FLOWERS, by Olive L. Earle. Cloth. 64 pages. 16.5×21 cm 1951. William Morrow and Company, Inc., 425 Fourth Avenue, New York 16, N. Y. Price $2.00.

Here is a well illustrated book for all nature lovers. Each state of the Union is given a page which shows an outline map with the location and name of the capital city, pictures of the state flower and bird, and a number of other related sketches. A very interesting and instructive paragraph tells the principal characteristics and habits of the bird and describes briefly the life of the flower. California and New Hampshire are examples of states that require two pages since no other state has adopted either its bird or flower. Only one important thing is lacking—the natural colors of the birds and flowers, but this would have greatly increased the cost.

THE GREAT WHALES, by Herbert S. Zim. Cloth. 64 pages. 16.5×20.5 cm. 1951. William Morrow and Company, Inc., 425 Fourth Avenue, New York 16, N. Y. Price $2.00.

This little book will interest everyone because it tells about the life of the largest animal known. Dr. Zim gives the facts in language every girl and boy can fully understand. James Gordon Irving has supplied wonderful drawings for every page. On many pages much more is said in the illustrations than in the type. This is a fine gift book for anyone.

ANIMAL TOOLS, by George F. Mason. Cloth. 94 pages. 12×20.5 cm. 1951. William Morrow and Company, Inc., 425 Fourth Avenue, New York 16, N. Y. Price $2.00.

Animal Tools is another book for children of all ages. It is interesting throughout, from the discussion of the stone anvil of the sea otter to the flash light of the firefly. Many pages of drawings illustrate the descriptions and supply additional information.

PLAY WITH VINES, by Millicent E. Selsam. Cloth. 63 pages. 15.5×20 cm. 1951. William Morrow and Company, Inc., 425 Fourth Avenue, New York 16, N. Y. Price $2.00.

This book tells of the "hands" of climbing plants. Some use their entire bodies and are known as twining vines such as the morning glory; others like the clematis and the canary-bird flower are leaf climbers; grapes and beans use tendrils; the ivy and trumpet vines climb with their roots.

Teachers still take pride in belonging to a profession, even though they work under conditions no day laborer would tolerate. It is this pride which prevents many of them from uniting in the national teachers' union to secure the three great boons for which every teacher prays: better salaries, lightening of the teacher "load," and abolishing the evils of mal-administration.—ANNA SOMMER LENN in *The American Teacher.*